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VOL. 48 SEPTEMBER, 1952 NO. 2

Revision of the Subfamily Leucochloridiinae Poche, 1907 (Trematoda: Brachylaemidae)*

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INTRODUCTION

The literature dealing with the subfamily Leucochloridiinae Poche, 1907 is vast. An era of confusion in the identification of species in the genus *Leucochloridium* Carus, 1835 prevailed during the several decades preceding and following the turn of the century largely because of a disregard for the significance of the arrangement of the genital glands in the known species. Maximilian Braun apparently had small appreciation of the significance of the internal morphology of the various species which he examined within this genus, for in a series of papers (1901, 1902) that influenced many workers he reduced all known species to synonymy with *Leucochloridium macrostomum* (Rudolphi, 1803). The genus *Leucochloridium* has been critically treated taxonomically only by Witenberg (1925) who, because of his emphasis on host specificity, made some serious errors of judgment in recognition and synonymy of several species. He rejected practically all the taxonomic conclusions presented in the literature by the earlier workers when he placed many of the species therein described in the category of *species dubiae* until the time "wenn eine umständliche Revision der Typen ihre Stellung im System festellen wird."

A foundation for a thorough revision of the concepts regarding the taxonomy of this genus was laid by Szidat (1936) who restudied Rudolphi's material deposited in the Berlin Museum and redescribed and validated two of Rudolphi's species, *D. macrostomum* and *D. holostomum*. He also pointed out that the species identified by Zeller (1874) and Heckert (1889) as *D. macrostomum* and so accepted for more than 60 years were distinct and different from Rudolphi's *D. macrostomum* and *D. holostomum*. He recognized three morphological types of Leucochloridium, namely: distomes with the genital glands in a straight line represented by *D. macrostomum* Rud., distomes with the genital glands in a triangle similar to the species of Heckert (1889) and Zeller (1874), and those with these glands in a triangle and with an intracaecal uterus similar to *D. holostomum* Rud. On

* Contribution from the Department of Zoology, University of Michigan. This paper is part of a dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

the basis of my own life history studies (Kagan, 1951) and studies of specimens collected by me and of my re-examination of many type specimens on deposit in the U. S. National Museum and further on the basis of Szidat's redescription of the type material of *D. macrostomum* and *D. holostomum*, I believe it is now possible and desirable to rectify some of the existing misconceptions of the taxonomy of this genus.

I was led to suspect that the genus *Leucochloridium* was not a taxonomic unit when my study of the morphology of *Neoleucochloridium problematicum* (Magath, 1920) new comb. revealed that the cirrus of the mature worm was pustulated. This type of cirrus is quite different from the long smooth cirrus figured by McIntosh (1932: 38) and the short cirrus figured on p. 46 of the same paper.

Fortunately I have been able to collect and compare *inter se* distomes of the three types postulated by Szidat. The morphology of these three types supported by comparisons with the morphology of species described in the literature reveals that the genus *Leucochloridium* constitutes in reality a complex of three distinct genera. The differences between these genera are based on a complex of characters, rather than on a single character Each genus contains species from all parts of the world and exhibits host specificity in a limited way. Measurements of the species reported in the literature were collected and tabulated. These tables are included in the original copy of the thesis which is on deposit in the library of the University of Michigan.

I wish to express my sincere appreciation to Dr. George R. LaRue for the many helpful suggestions and criticisms given during the course of this study, and to Allen McIntosh for his aid in various parts of the work.

Subfamily LEUCOCHLORIDIINAE Poche, 1907

Poche (1907), on the basis of priority, invalidated the name of the subfamily Urogoniminae Looss, 1899 changing it to Leucochloridiinae. The family Harmostomidae has been revised by many workers, and Mehra (1936) who made one of the most recent revisions recognized the following genera in the subfamily Leucochloridiinae Poche: *Leucochloridium* Carus, 1835 (=*Urogonimus* Monticelli, 1888), *Urotocus* Looss, 1899, *Urorygma* Braun, 1901, and *Panopistus* Sinitsin, 1931.

The genera *Urorygma* and *Panopistus* are excluded from the subfamily for reasons stated in the subsequent discussion.

Genus URORYGMA Braun, 1901

Urorygma Braun, 1901: 942; 1902: 138; Pratt, 1902: 889; Viana, 1924: 135; Poche, 1926: 173; Fuhrmann, 1928: 129; Odhner, 1912: 55; 1927: 7; Travassos, 1928: 329; Dollfus, 1934: 553; Mehra, 1936: 235.

The genus *Urorygma* was erected for *Urorygma nanodes*, a species collected from a Brazilian bird, *Falco nitidus*, but the species was not thorough-

ly described because of the gravid condition of the uterus which obscured the internal morphology. The characters observed by Braun (1901) that lead me to believe that this genus does not belong to the subfamily Leucochloridiinae are: the vitellaria do not extend posteriad beyond the acetabulum and the testes lie side by side in front of the acetabulum with ovary in the median plane behind the testes and dorsal to the acetabulum. Braun placed this genus in close affinity with the genus *Urogonimus* Monticelli, 1888, *Urotocus* Looss, 1889, and *Urotremata* Braun, 1900 because the genital pore of *Urorygma* is subterminal as in these genera. *Urorygma* was placed in the subfamily Urogoniminae Looss by Pratt (1902). When the family Harmostomidae was erected by Odhner (1912) he excluded this genus because of the position of the genital glands, but he later (1927) related *Urorygma* to the genus *Urogonimus* becuase of the position of the genital pore. *Urorygma* was placed among the *genera sedis incertae* by Poche (1926), designated as "genero incerto" by Travassos (1928), and returned to the subfamily Harmostominae by Fuhrmann (1928). Viana (1924) and Mehra (1936) placed it in the subfamily Leucochloridiinae Poche, 1907, and Dollfus (1934) in his newly erected family Leucochloridiidae.

The family Brachylaemidae, as it is now characterized, cannot include this genus, hence it is proposed that it be placed among the *genera incertae* until such time that it can be placed more accurately as the result of life history studies.

Genus PANOPISTUS Sinitsin, 1931

Panopistus Sinitsin, 1931: 826; Dollfus, 1934: 553; Krull, 1934: 5; 1935: 93; Mehra, 1936: 235.

Sinitsin (1931) erected the genus *Panopistus* for three larval forms, *P. magnus*, *P. oviformis*, and *P. pricei* found in terrestrial snails near Washington, D. C., placing them in the tribe Ectosiphonea in the subfamily Harmostominae. Dollfus (1934) raised the subfamily Leucochloridiinae to family rank and recognized the genera *Leucochloridium* Carus, 1835, *Urotocus* Looss, 1899, *Urorygma* Braun, 1901 "(et, dubitativement peut-être dans une sous-famille séparée, *Panopistus* Sinitsin 1931)." Krull (1934, 1935) described the various stages in the life cycle of *Panopistus pricei* without discussing the taxonomic position of the genus.

The life history of *Panopistus pricei* Sinitsin shows close affinity between this species and members of the subfamily Brachylaeminae. Its sporocysts, cercariae, and metacercariae are similar in morphology to corresponding stages of other members of the subfamily. The sporocyst does not resemble that known to be characteristic of the Leucochloridiinae. It is therefore proposed that *Panopistus* be placed in the subfamily Brachylaeminae where Sinitsin (1931) assigned it.

Now that the genera *Urorygma* Braun and *Panopistus* Sinitsin have been excluded from the subfamily Leucochloridiinae the subfamily diagnosis is emended as follows:

Subfamily LEUCOCHLORIDIINAE Poche, 1907, emend.

Subfamily diagnosis.—Brachylaemidae: Body elliptical, oblong or oval. Cuticle smooth or spinose. Suckers weakly developed or large. Excretory pore dorsal, subterminal; excretory vessels unciliated. Pharynx small or large. Esophagus short or absent. Genital pore dorsal or ventral, terminal or subterminal. Testes and ovary in line or in triangular position. Cirrus sac muscular. Receptaculum seminis present. Vitellaria lateral, extending posteriorly beyond acetabulum. Uterus extending in front of acetabulum. Eggs small. Parasites of bursa Fabricii, cloaca or intestine of birds.

Type genus.—*Leucochloridium* Carus, 1835.

Additional genera.—*Urotocus* Looss, 1899, *Urogonimus* Monticelli, 1888, *Neoleucochloridium* gen. nov.

Genus UROTOCUS Looss, 1899

Urotocus Looss, 1899: 654; Odhner, 1912: 55; Solowiow, 1912: 94; Witenberg, 1925: 222; Travassos, 1928: 328; Fuhrmann, 1928: 129; Dollfus, 1934: 553; Sinitsin, 1931: 831; McIntosh, 1935: 55; Mehra, 1936: 235.

The genus *Urotocus* Looss, 1899 was erected for the species *Urogonimus rossittensis* Mühling, 1898. This genus was separated from the genus *Urogonimus* Monticelli because of the poor development of the organs of attachment. Looss placed the two genera in the subfamily Urogoniminae, separating them from the subfamily Heterolopinae. The genus *Heterolope* Looss, 1899 was shown by Braun (1900: 12) to be a synonym of the genus *Harmostomum* Braun and on the basis of priority Heterlopinae was changed to Harmostominae. Solowiow (1912) did not recognize the genus *Urotocus* and returned the type species to the genus *Urogonimus* Mont. Odhner (1912) placed *Urotocus* in his newly created family Harmostomidae, subfamily Harmostominae. Witenberg (1925) erected 4 tribes in the subfamily Harmostominae: Urotocea, Leucochloridea, Harmostomea, and Ithyogonimea. Travassos (1928) accepted Witenberg's classification, but Fuhrmann (1928) left the genus in the subfamily Harmostominae without giving recognition to the tribes of Witenberg. Sinitsin (1931) divided the family Harmostomidae into the subfamilies Harmostominae and Leucochloridiinae and placed the genus *Urotocus* in the former subfamily in the newly erected tribe Entosiphonea. Dollfus (1934) placed the genus in the family Leucochloridiidae; however, Mehra (1936) returned the genus to the subfamily Leucochloridiinae.

Mühling (1898) in describing *Urogonimus rossittensis* wrote "wir finden also in den Grundzügen in dem *Urogonimus rossittensis* den Bauplan des *Urogonimus macrostomus* widerholt." I believe that Looss was justified in erecting the genus *Urotocus* for this species because of the rudimentary nature of the suckers. McIntosh (1935) described a second member of this genus, *Urotocus fusiformis*, from a Warbler, *Oporornis philadelphia*, in which the evolutionary trend towards reduction of the suckers has progressed so far that the oral sucker is exceedingly small and the acetabulum has disappeared entirely. McIntosh linked the two genera *Leucochloridium*

and *Urotocus* because of the "general morphology of the reproductive system" but separated them because of the "general topography of the body."

Genus UROTOCUS Looss, 1899 emend.

Generic diagnosis.—Leucochloridiinae: Body elongate, fusiform. Suckers weakly developed, acetabulum sometimes absent. Cuticula spinose. Pharynx small. Genital glands in line in posterior fourth of body. Genital pore terminal or subterminal on ventral surface. Cirrus sac small. Cirrus short. Receptaculum seminis absent. Laurer's canal present. Vitellaria extracaecal, extending posteriorly to level of ovary. Uterus intracaecal, extending nearly to pharynx. Eggs small. Parasites in bursa Fabricii of passerine birds.

Type species.—*Urotocus rossittensis* (Mühling, 1898).

Additional species.—*Urotocus fusiformis* McIntosh, 1935.

Genus UROGONIMUS Monticelli, 1888

Urogonimus Monticelli, 1888: 92; 1892: 122; 1893: 157; Stiles and Hassall, 1898: 95; Looss, 1899: 653; Brauna, 1902: 136; Pratt, 1902: 889; Poche, 1907: 125; Odhner, 1912: 55; Viana, 1924: 159; Dollfus, 1934: 553; Fuhrmann, 1928: 129; Mehra, 1936: 235.

The genus *Urogonimus* with *D. macrostomum* Rud., 1803 designated as the type species was erected by Monticelli (1888) in his revision of the subfamily Distominae Retzius. This name was based on the posterior position of the genital pore. The genus *Leucochloridium* had been erected by Carus (1835) more than 50 years earlier for a sporocyst which he named *L. paradoxum*. By experiment the contents of a sporocyst identified as *L. paradoxum* were shown by Zeller (1874) to develop into a distome species which he erroneously believed to be *D. macrostomum* Rud. The question of the validity of *Leucochloridium* vs. *Urogonimus* when considered by Stiles and Hassall (1898) was decided by them in favor of *Urogonimus*. Their decision was based on Art. 48b of the first "Règles de la Nomenclature Congrès Internat. Zool." under which larval forms were not entitled to priority. In the revision of the "Règles" in 1901 the priority of designations of larval forms was established and formed the basis on which Poche (1907) stated that *Leucochloridium* Carus, 1835 had priority over *Urogonimus* Monticelli, 1888 and that the latter thus became a synonym of the former.

However, redescription by Szidat (1936) of *D. macrostomum* Rud. based on Rudolphi's specimens in the Berlin Museum demonstrated that Rudolphi's *D. macrostomum* was distinct from the species identified as *D. macrostomum* by Zeller which he had secured by feeding the sporocyst named earlier as *L. paradoxum*. The name of Zeller's species therefore reverts to *L. paradoxum* Carus, 1835, thus making *D. macrostomum* Rud., 1803 available for use as the type species of the genus *Urogonimus* Monticelli, 1888.

There still remains for solution the question whether *macrostomum* and *paradoxum* belong in the same genus. If congeneric, the genus Urogonimus

must fall because of priority of *Leucochloridium*. However, it will be shown later that the species are not congeneric and that, therefore, both generic names are valid.

The criteria adopted for differentiating species within the genus are: the arrangement of the genital glands, in line or in triangular position; position of acetabulum and its size in relation to oral sucker; extension of uterus into area of pharynx and oral sucker; posteriad extension of vitellaria and extent of overlap of intestinal caeca; size of ovary in comparison to size of testes.

No life histories are known for members of this genus.

Genus UROGONIMUS Monticelli, 1888 emend.

Generic diagnosis.—Leucochloridiinae: Distomes rounded at both ends. Suckers large and well developed. Cuticula with or without spines. Genital pore terminal or slightly subterminal. Excretory pore, dorsal, anterior to genital pore. Laurer's canal opening dorsally anterior to excretory pore. Uterus ascending to level of oral sucker, returning on same side of body and circling posterior rim of acetabulum, then passing over to other side of body and after ascending to level of oral sucker reversing and terminating at genital pore. Metraterm bulbous, muscular. Cirrus pouch, when present, muscular, small. Vesicula seminalis bulbous, muscular, attached to cirrus pouch. Cirrus round, short, stubby. Genitalia in tandem or triangular arrangement. Seminal receptaculum present. Vitellaria lateral, extending posteriad beyond testes. Parasites in digestive tract of passerine birds.

Type species: Urogonimus macrostomus (Rudolphi, 1803).

Additional species: *U. caryocatactis* (Zeder, 1800) new comb. (= *D. caudale* Rudolphi, 1809; *D. caudale* Mueller, 1897); *U. witenbergiella* sp. nov.; *U. seiuri* (McIntosh, 1932) new comb.; *U. dryobatae* (McIntosh, 1932) new comb.; *U. witenbergi* Skrjabin, 1948; *U. certhiae* (McIntosh, 1927) new comb.; *U. cardis* (Yamaguti, 1939) new comb.; *U. mniotiltae* (McIntosh, 1927) new comb.; *U. icteri* (McIntosh, 1927) new comb.; *U. vireonis* (McIntosh, 1927) new comb.; *U. parcus* (Travassos, 1922) new comb.; *U. turdi* (Yamaguti, 1939) new comb.; *U. dasylophi* (Tubangui, 1928) new comb.; *U. mesostomus* (Rudolphi, 1803) sp. dub.; *U.* sp. Lutz, 1921 sp. dub.

UROGONIMUS MACROSTOMUS (Rudolphi, 1803)

Fasciola macrostoma Rudolphi, 1803: 26. *Distomum macrostomum* Rudolphi, 1809: 386; 1819: 104; Westrumb, 1821: 72; Bremser, 18824: 133; Dujardin, 1845: 443; Diesing, 1850: 361; Creplin, 1851: 285; Schlotthauber, 1860: 130; Hausmann, 1899: 448; Wolffhuegel, 1900: 45; Szidat, 1936: 646. (non) *Distomum macrostomum* Zeller, 1874: 564-578; Braun, 1901: 566; Heckert, 1887: 461; 1889: 1-66; Stossich, 1892: 41, 50. *Urogonimus macrostomus* Monticelli, 1888: 92: 1892: 122; 1893: 157; (?) Kowalewski, 1902: 253. (non) *Urogonimus macrostomus* Stossich, 1896: 127; Braun, 1901: 568; 1902: 136-137; Skrjabin, 1913: 369; Lutz, 1921: 136; Fuhrmann, 1928: 61. *Leucochloridium macrostomum* Poche, 1907: 125; Lühe, 1909: 144; (?) Ritchie, 1916: 43; (?) André, 1917: 174; (?) Baylis, 1928: 332; (?) Skrjabin, and Massino, 1925: 453; (nec Witenberg, 1925: 232); (?) Solonitsyn, 1928: 94; (nec Bovien, 1932): 7); (?) Shtrom, 1935: 250; (?) Korkhaus, 1935: 39; (?) Vasiliu, 1939: 93; (?) Markov, 1940: 749.

Rudolphi (1803) did not describe the internal anatomy of *U. macrostomus* in his original characterization, but he did describe the cirrus thus: "eine kleine an der Spitze durchbohrte Kugel, die, wie man zurweilen sieht, an einem kleinen Steil hängt." A short stubby cirrus, genital glands in a

straight line and uterus circling the posterior rim of the acetabulum are three of the most outstanding characters of this genus. Szidat (1936), although he overlooked the cirrus and did not mention it when he restudied Rudolphi's original material secured from the Berlin Museum, did find the genital glands in a line and therefore concluded that *D. macrostomum* Rud. was not identical with the species with genital glands in triangular position described by Zeller (1874) and by Heckert (1889) as *D. macrostomum*.

This species was first described by Rudolphi (1803) under the name of *Fasciola macrostoma* from *Motacilla luscinia*. Rudolphi (1819) reported as additional hosts, *Motacilla flava, Sylvia cinerea, S. nisoria* and *S. fluviatilis*. The catalogue of the Vienna Museum listed an additional host, *Motacilla passerina* reported by Westrumb (1821) and Dujardin (1845). Diesing (1850) reduced *D. erraticum* Rud., 1819, *D. ringens* Rud., 1819 and *D. philomelae* Rud., 1819 to synonymy with *D. macrostomum*. Braun (1902) pointed out that the specimens labelled *D. erraticum* in the Berlin Museum were in reality an assemblage of various species including Plagiorchids and Brachylaemids and that in only two instances in *Fringilla linariae* and *Parus palustrus* were the specimens members of this genus. Szidat (1936) showed that *D. ringens* Rud. from *Picus tridactyles* was similar to *D. macrostomum* Rud. *D. philomelae* from *Motacilla philomelae* is listed among "species dubiae" in Rudolphi's "Entozoorum Synopsis" and, until the original specimens (if they are still available) are reinvestigated, the species should remain in the category designated by Rudolphi. Creplin (1851) reported *D. macrostomum* from *Thoryotorus hypoxanthus*, an unidentifiable host, and Schlotthauber (1860) probably in error listed this species from *Petromyzonis fluviatilis*, a cyclostome.

With the exception of Bremser's (1824) outline figure of Rudolphi's specimen, showing little more than the two suckers and a gravid uterus, Zeller's published figure of his species erroneously identified as *D. macrostomum* was the first detailed figure to appear in the literature. Zeler (1874) probably assumed he was working with Rudolphi's species because of the terminal genital pore and because his experimental and natural infections were found in hosts similar to the hosts reported by Rudolphi. Characters thought today to be worthy of generic separation were not recognized as worthy of specific separation by Zeller, for after consulting drawings of *Neoleucochloridium holostomum* (Rud.) new comb. from *Gallinula chloropus* loaned him by Von Siebold, he came to the conclusion that the two were synonymous and differed only in size. Zeller's erroneous opinion was substantiated by Mühling (1898), Braun (1901, 1902), and Heckert (1889).

Heckert (1887) in a preliminary report outlined the life history of another species also erroneously believed to be *D. macrostomum*, and his thesis entitled "*Leucochloridium paradoxum*—Monographische Darstellung der Entwicklungs-und Lebensgeschichte des Distomum macrostomum" when it was published (1889) again had a tremendous influence on the concept of species

in this genus. Heckert's figure of his species and details of the life cycle are to be found in many books and papers. In the discussion of this species below only those references that are significant are reported.

Since the species *macrostomum* of Zeller and Heckert are properly assigned to the genus *Leucochloridium* and are not congeneric with *U. macrostomus* (Rud.) those reports of *L. macrostomum* subsequent to Zeller and Heckert and not accompanied by figure or description are incapable of analysis and their specimens cannot properly be assigned to a genus.

Stossich (1896) described and figured a species from the intestine of *Numenius tenuirostris* as *D. macrostomum* which belongs in the genus *Leucochloridium*. However, because the specific diagnosis is so brief and the figure so poor, this species must be listed as *species inquirenda*.

The following workers reported specimens from many bird hosts without description or figure: Hausmann (1899), Wolffhuegel (1900), Kowalewski (1902), Skrjabin (1913), Ritchie (1916), André (1917), Skrjabin and Massino (1925), Baylis (1928), Solonitsyn (1928), Bovien (1932), Shtrom (1935), Korkhaus (1935), Vasiliu (1939) and Markov (1940).

Braun (1902) examined many of the original specimens in the Berlin and the Vienna Museums for source material in his taxonomic papers "Zur Revision der Trematoden der Vögel" and "Fascioliden der Vögel." Many earlier errors in identification were corrected and invaluable information was supplied, but Braun's concept of specific characters caused him to lump under the name *Urogonimus macrostomus* many species in this subfamily with terminal genital pore and with posteriorly located genital glands. Distomes reported from *Parus major* and *Motacilla alba* by earlier workers were found to be other than *Urogonimus* species.

Lutz (1921) reported several *Urogonimus* species from Brazil. At that time he was not ready to state whether they were similar to, or different from, the European species, but expressed the opinion that *U. macrostomus* was in reality two species, one living in passerine birds and the other in water birds. He further believed that the species from passerine birds have sporocysts of green and white and red pigment, but that the species developing in water birds came from sporocysts with brown pigment, similar to the brown sporocysts described by Heckert. Lutz also stated that *D. holostomum* Rud., the species from the Gallinule, was not synonymous with *D. macrostomum* Rud.

Skrjabin and Massino (1925) reported 12 hosts for *L. macrostomum* (Rud.) in Russia. The specimens from these collections were used by Witenberg (1925) in his taxonomic study of the subfamily Harmostominae. Witenberg figured several of these species thus enabling me to properly assign some to the genus *Urogonimus*. Witenberg recognized three species in the genus *Leucochloridium*: *L. macrostomum* (Rudolphi) for the species from passerine birds, *L. insigne* (Looss) for the species from shore birds, and *L. turanicum* (Solowiow) for the species from swamp birds. These species are dealt with separately elsewhere. I am convinced that host

specificity is not as limited as Witenberg believed, for species of *Urotocus* and *Urogonimus* are limited mainly to passerine birds, whereas species of the genus *Leucochloridium* parasitize passerine and shore birds, and species of the genus *Neoleucochloridium* gen. nov. mainly birds of the orders Gruiformes and Galliformes. *L. macrostomum* of Witenberg differs from *U. macrostomus* (Rud.), but is congeneric with the latter, hence is renamed (*v. infra*).

Fuhrmann (1928) in the section on Trematodes in Kükenthal's "Handbuch der Zoologie" presented an original figure of *Urogonimus macrostomus* from *Gallinula chloropus* that appears from his drawing to be a composite of several species, for the course of the uterus is typical of worms of the genus *Urogonimus*, while the arrangement of the genital glands and character of the cirrus fit the genus *Leucochloridium*, and the host is characteristic for the genus *Neoleucochloridium*. In my opinion this species is not valid, but is a composite of several species.

Among the 14 species recognized as valid in this genus, *Urogonimus macrostomus* (Rud.) reported from Europe, *U. dryobatae* (McIntosh) from the United States and *U. cardis* (Yamaguti) from Japan, form a group of species with the genital glands occupying most of the post-acetabular space; genital glands in linear series; ovary larger than testes. The post-equatorial position of the acetabulum in *U. cardis* separates this species from the other two; the extension of the uterine loops, limited more or less to the area of the pharynx and posterior border of the oral sucker in *U. macrostomus* and extending well beyond the posterior margin of the oral sucker in *U. dryobatae*, separates these two species from one another.

Urogonimus dryobatae (McIntosh, 1932) new comb.

Leucochloridium dryobatae McIntosh, 1932: 43; 1935: 431; Reynolds, 1936: 409.

Urogonimus dryobatae has been collected in the United States by McIntosh (1932), R. Rausch (unpublished), E. L. Cheatum (unpublished) and B. D. Reynolds (1936). There are specimens of *U. dryobatae* in McIntosh's collection wherein the uterine coils do not extend into the area of the oral sucker, thus nullifying the distinction made between this species and *U. macrostomus* from Europe. Perhaps when the life cycles of these two species are known other significant differences or similarities will be revealed. For the present, however, it is deemed best to regard these species as distinct until experimental evidence is available to prove or disprove the value of the color of the broodsac as a specific character. In color, the broodsacs of the European and American species are not similar.

The ovary of *U. dryobatae* may be in line or displaced to one side to make a triangle with the testes. In 20 worms recovered from the cloaca of a Song Sparrow shot by me near Ann Arbor, Michigan, 6 individuals showed this latter character. In the same collection 11 specimens possessed an ovary slightly smaller than the testes. With respect to the variation of the size of ovary in relation to that of the testes, the lower zone of variation

in *U. dryobatae* overlaps the upper zone in *U. certhiae*. The significance of the size of ovary to testes can be determined only by means of life history studies. The characters that separate *dryobatae* and *certhiae* are fundamentally different so that a study of several specimens makes a specific determination rather easy.

Urogonimus cardis (Yamaguti, 1939) new comb.

Leucochloridium cardis Yamaguti, 1939: 185-186.

This single specimen collected from *Turdus cardis cardis* in Japan represents the "macrostomum type" in Asia. The course of the uterus and the opening of Laurer's canal on the mid-dorsal surface at the level of the posterior testis places this species in the genus *Urogonimus*. The slight post-equatorial position of the acetabulum in *U. cardis* separates this species from *U. macrostomus* (Rud.) and *U. dryobatae* (McIntosh) which are closely related to it.

Urogonimus certhiae (McIntosh, 1927) new comb.

Leucochloridium certhiae McIntosh, 1927: 355; 1932: 45; 1935: 431.

This species collected from *Certhia familiaris americana* and from *Melospiza melodia beata* is characterized by having an ovary much smaller than the testes. Specimens, collected from Song Sparrows in the Ann Arbor region and kindly placed at my disposal by E. L. Cheatum, show a wide variation in size between ovary and testes in specimens collected from the same host species in the same area on the same day. Among 68 specimens examined, the size of ovary in several specimens approaches that of the testes, but in no instance does it exceed the testes. Whether these specimens can be assigned to *U. certhiae* cannot be determined; however, if they are of that species, a wide variation is manifested. Specimens with an ovary larger than average resemble *U. mniotiltae* (McIntosh), but may be separated from the latter by the character of the uterine loops and the nature of the vitellaria.

Urogonimus mniotiltae (McIntosh, 1927) new comb.

Leucochloridium mniotiltae McIntosh, 1927: 357; 1932: 47; 1935: 431.

U. mniotiltae from *Mniotilta varia* and *Oporornis agilis* is most closely related to *U. certhiae* and is differentiated from the latter by McIntosh on the relative size of ovary to testes. Examination of many *U. certhiae* from Song Sparrows showed specimens intergrading into types very similar to *U. mniotiltae* with respect to this character. These two species may be separated by the following characters: in *U. mniotiltae* the uterine loops do not extend into the area of the oral sucker as in *U. certhiae*, nor do the vitellaria extend as far posteriad as in *U. certhiae*. Until life history studies point out the relative significance of these characters, *U. mniotiltae* is regarded as a distinct species.

Urogonimus witenbergiella, sp. nov.

Leucochloridium macrostomum of Witenberg, 1925: 235; Bovien, 1932: 7.

This species was described by Witenberg (1925) as *L. macrostomum* for the following reasons: specimens in his collection from shore birds and believed to be identical with *L. insigne* (Looss) were similar to *L. macrostomum* of Zeller and of Heckert; the type species, *L. macrostomum* (Rud.) had not been properly described; his species and the type species were of approximately the same size and both were found in passerine birds; he did not believe he was justified in creating a new species when the characters of the type species were unknown.

L. macrostomum of Witenberg is not similar to *U. macrostomus* (Rud.) the type species, and is renamed in Witenberg's honor. *U. witenbergiella* sp. nov. differs from *U. macrostomus* by the following characters: the genital glands are in an oblique line, not parallel to the longitudinal axis of the body; the ovary is much smaller than the testes. This species is most closely related to *U. mniotiltae* McIntosh from which it can be separated only by the lack of a prominent Mehlis' gland.

Bovien (1932) reported a species from the Faeroe Islands as similar to *U. witenbergiella* (*L. macrostomum* of Witenberg). This may be a second record of this species from Europe.

Urogonimus witenbergi Skrjabin, 1948

Leucocochloridium sp. of Witenberg, 1925: 239; McIntosh, 1932: 45; Skrjabin, 1948: 291.

This species was described from *Muscicapa grisola* as *L.* sp. by Witenberg (1925) and separated from *U. witenbergiella* on its larger size of body and size os testes. *U. witenbergi* is one and one-half times as large as *U. witenbergiella* and the testes are larger than the pharynx. McIntosh (1932) pointed out that this species is "closely related to, if not identical with *L. certhiae*." I agree with McIntosh, but feel that when these species are reduced to synonymy it should be on the basis of life history studies, and not entirely on comparative morphology. This species may be separated from *U. certhiae* (McIntosh) on the basis that the uterine loops do not extend into the area of the oral sucker.

Comparison of life history studies of European species in this subfamily has shown that the larval stages, especially the color of the broodsacs, do not agree in all details with the larval stages found in North America. Until it can be shown on an experimental basis that the color of the broodsac carries no specific value it seems best to separate the European species from the American species.

Urogonimus seiuri (McIntosh, 1932) new comb.

Leucochloridium seiuri McIntosh, 1932: 41.

U. seiuri from the Ovenbird, *Seiurus aurocapillus*, is differentiated from

the other members of the genus in that the uterus is intracaecal and the genital glands are arranged in a straight line, slightly oblique, intermediate between *U. dryobatae* and *U. witenbergi*. McIntosh figured an atypical specimen, since many of the cotypes examined show the normal intracaecal position of the uterus.

Urogonimus caryocatactis (Zeder, 1800) new comb.

Distoma caryocatactis Zeder ,1800: 168. *Distomum caudale* Rudolphi, 1809: 382-384; 1819: 103; Siebold, 1848: 121; Dujardin, 1845: 442; Diesing, 1850: 362; Mueller, 1897: 16; Mühling, 1898: 99. (non) *Brachylaemus caryocatactis* Dollfus, 1935: 69. (non) *Distomum caudale* Willemoes-Suhm, 1870: 97; Stossich, 1892: 36; Dollfus, 1934: 559; 1935: 52, 68. (non) *Harmostomum caudale* Braun, 1901: 562; 1902: 123; Witenberg, 1925: 220.

This species from *Nucifraga caryocatactes* was briefly described by Zeder (1800). The description dealt chiefly with the external anatomy, but Zeder saw and characterized the cirrus as follows: "ein kurzen weisses, walzenrundes, warzenformiges Gefass." Although the original specimens are lost, the description of the cirrus and position of the genital pore "in der Nahe des Hinterendes unter der Bauchwartz" leads me to accept this species as a member of this genus.

Rudolphi (1809) renamed *D. caryocatactis* as *D. caudale* because of the posterior position of the genital pore and he (1819) listed a second host, *Pyrrhocoracis glandarius*. Dujardin (1845) reported that Bremser had found this species three times in *Nucifraga caryocatactes* and twice in *Corvus glandarius* and noted the fact that Rudolphi had used Bremser's specimens. Von Siebold (1848) made reference to *D. caudale* and *D. holostomum* as being species with terminal genital pore, observations which indicate that he probably recognized these two species as being distinct. Diesing (1850) in addition to listing the above mentioned hosts reported this species from a third host, *Corvus pyrrhocorax*. A distome found in *Corvus alpinus* with genital pore opening between acetabulum and oral sucker was reported by Willemoes-Suhm (1870) and assumed by him to be *D. caudale* Rud. He altered Rudolphi's original description to fit the organization of his species. Stossich (1892) placed *D. caudale* of Rudolphi in *species inquirenda*. Mueller (1897) described and figured a species from *Coracias garrulus* as *D. caudale* Rud. which he said fitted Rudolphi's diagnosis of *D. caudale* so closely that Willemoes-Suhm was in error when he emended the original generic diagnosis to fit his species. I concur in Mueller's opinion and assume that Mueller's species taken from the same country is a subjective synonym of *D. caryocatactis* Zeder. Mueller, like Monticelli (1893) and Hohorst (1937), mistook the posterior testis for the ovary, but his figure and description demonstrate that his species should be assigned to *Urogonimus*. Mühling (1898) stated that he had investigated the possibility that *D. caudale* Rud., *D. mesostomum* Rud. and *D. macrostomum* Rud. may be synonyms, but because the original specimens were not available he could not come to any decision. Braun (1902) restudied the specimens on

deposit in the Vienna Museum. In that collection were specimens labelled *D. caudale* from *Pica caudata, Nucifraga caryocatactes* and *Pyrrhocorax alpinus*. The specimens from *Pica caudata* proved to be a species of *Opisthorchis*, those from *Nucifraga caryocatactes* a *Plagiorchis* sp., and those from *Pyrrhocorax alpinus*, deposited by Diesing, an undescribed species of *Harmostomum*... Braun considered the characterizations by Zeder and Rudolphi for *caryocatactis* and *caudale* to be incomplete and stated that they could not be recharacterized since no type specimens were available. Moreover, since he had placed *D. caudale* of Mueller in synonymy with *D. macrostomum* of Zeller and of Heckert, Braun described the specimens deposited by Diesing from *Pyrrhocorax alpinus* as *Harmostomum caudale* (Rudolphi), transferring the species from the genus *Urogonimus* to the genus *Harmostomum*.

The name *Harmostomum caudale* (Rudolphi) for Diesing's specimen must be rejected as a homonym of *Urogonimus caryocatactis* (= *D. caudale* Rudolphi) Zeder new comb. *D. caudale* Rud. is a synonym of *D. caryocatactis* Zeder because Rudolphi merely renamed Zeder's species and translated most of Zeder's diagnosis into Latin. Zeder's description of the cirrus and external morphology of *D. caryocatactis* places this species in the genus *Urogonimus*. Inasmuch as *D. caudale* of Diesing is different from *D. caryocatactis* of Zeder, I propose the name *Brachylaemus brauni* for *Harmostomum caudale* of Diesing. This species described by Braun from Diesing's specimens was placed in *species inquirenda* by Witenberg (1925). Dollfus (1934) stated that he believed that *Brachylaemus accuatus* from *Garrulus glandarius* "semble extrement voisin de *Distoma caudale* Rud. (nomen novum pro *Distoma caryocatactis* Zeder)." He (1935) further stated that *D. caudale* Linstow was synonymous with *Brachylaemus erinacei* Blanchard. I was not able to locate any reference to Linstow's species. He also listed *D. caudale* as (?) *Brachylaemus caryocatactis*.

The morphology of *Urogonimus caryocatactis* (Zeder) new comb. based on Mueller's specimens and description differs from that of *Urogonimus macrostomus* (Rud.) chiefly in the size of the area occupied by the genital glands. In *U. macrostomus* (Rud.) the entire space between the acetabulum and the end of the intestinal caeca is occupied by the genital glands, whereas in *U. caryocatactis* only the posterior third of this area is so occupied. *U. caryocatactis* most closely resembles *U. vireonis* (McIntosh), but is considered to be distinct because of the lack of uniformity in the color of broodsacs in known sporocysts of Europe and the Western Hemisphere.

Urogonimus icteri (McIntosh, 1927) new comb.

Leucochloridium icteri McIntosh, 1927: 357; 1932: 47; Travassos, 1928: 328.

The triangular position of the genital glands of *U. icteri* (McIntosh) led me at first to assume that this species belonged in the genus *Leucochloridium* where McIntosh placed it. When it was noticed that specimens of *U. dryobatae* (McIntosh), collected by me, in some instances had the

ovary in triangular position, the possibility was investigated that *U. icteri* belonged to the genus *Urogonimus*. The short vitellaria, characteristic of this genus, in comparison to vitellaria that extend to, or beyond, the end of the intestinal caeca in the other two genera, plus the fact that the ovary in McIntosh's figure of this species had the appearance of being slightly displaced to one side as though it were formerly in line with the testes, supported my hypothesis that this species and related species may belong to the genus *Urogonimus*. The subterminal position of the genital pore and the course of the uterus figured by McIntosh did not appear correct for a species of the genus *Urogonimus*. When the type specimens and cotypes on deposit in the U. S. National Museum were examined, the uterus of the specimen of *U. icteri* figured by McIntosh was found to be typical for this genus. However, eggs, released from a broken uterine loop caused by coverglass pressure, had spilled over into the area adjacent to the pharynx giving the impression that the uterus passed between the acetabulum and the pharynx when actually it circles behind the acetabulum as shown very distinctly in the cotypes. The genital pore is terminal and what is labelled genital pore is the opening of Laurer's canal. Whether the displaced ovary in this species is a constant character is open to question.

U. icteri (McIntosh), *U. vireonis* (McIntosh), *U. parcus* (Travassos), *U. dasylophi* (Tubangui), and *U. turdi* (Yamaguti) form a series of species in the genus *Urogonimus* that are alike in possessing genital glands in triangular configuration and which occupy only a portion of the area between acetabulum and end of body in contrast to those species with genital glands in line and occupying almost the entire post-acetabular area.

U. icteri most closely resembles *U. dasylophi* (Tubangui) described from the Philippine Islands. The acetabulum of *U. icteri* is slightly larger than the oral sucker, while in *U. dasylophi* it is much larger than the oral sucker.

Urogonimus vireonis (McIntosh, 1927) new comb.

Leucochloridium vireonis McIntosh, 1927: 359; 1932: 47; Travassos, 1928: 328.

U. vireonis, based on a single specimen taken by McIntosh from the White-eyed Vireo, *Vireo griseus*, closely resembles *U. icteri* (McIntosh), *U. parcus* (Travassos) and *U. caryocatactis* (Zeder). This species resembles *U. caryocatactis* in the size of the genital glands and their position in relation to the acetabulum. In both species these glands are far posterior, leaving a large gap between acetabulum and anterior testes. The genital glands of *U. caryocatactis* are in a straight line; those of *U. vireonis* in triangular position. It may be that had several specimens of *U. vireonis* been recovered some might have had the genital glands in a straight line The possibility exists that the ovary in *U. vireonis* was displaced by pressure in fixation since it is only slightly out of line with the testes. A specimen taken from the cloaca of a Long-Billed Marsh Wren (*Cistothorus palustris*) by E. L. Cheatum (unpublished) in southeastern Michigan is believed to be a specimen of *U. vireonis* with genital glands in tandem. *U. vireonis*

with genital glands in a line may be distinguished from *U. caryocatactis* in that the vitellaria do not extend as far posteriad as in the latter. The broad vitellaria that overlap the intesinal caeca and the forward extension of the uterine loops into the area of the oral sucker differentiate *U. vireonis* from the other two closely related species, *U. icteri* (McIntosh) and *U. parcus* (Travassos).

U. vireonis has two places in the key among the species with genital glands in line and those species with genital glands in triangular position.

Urogonimus parcus (Travassos, 1922) new comb.

Leucochloridium parcum Travassos, 1922: 189; 1928: 367; McIntosh, 1927: 363; Viana, 1924: 140, 148.

This Brazilian species reported from *Ostinops decumanus* and *Tachyphous cristatus* by Travassos is, I believe, closely related to *U. vireonis* (McIntosh). McIntosh (1927) related this species to *U. icteri* because the species are similar in size of body and in arrangement of organs and parasitize related bird genera. The extension of the uterine loops into the area of the oral sucker in both *U. parcus* and *U. vireonis* separates these species from *U. icteri.* Travassos reported a large, long and narrow cirrus pouch for this species. He may have mistaken another structure for the cirrus pouch, for this organ in all other described species is small and bulbous. The vitellaria of *U. parcus* are composed of fine follicles and are almost entirely extracaecal. These characters separate *U. parcas* from *U. vireonis,* for in the latter the vitellaria are composed of coarse follicles which overlap the intestinal caeca.

Urogonimus dasylophi (Tubangui, 1928) new comb.

Leucochloridium dasylophi Tubangui, 1928: 351-357; 1932: 380; McIntosh, 1932: 53.

U. dasylophi described from the Philippine Islands by Tubangui (1928) is placed in this genus because of its morphological similarity to *U. icteri.* Information on the course of the uterus, type of cirrus and opening of Laurer's canal is lacking. *U. dasylophi* (Tubangui), *U. icteri* (McIntosh) and *U. turdi* (Yamaguti) comprise a group of closely related species with genital glands in triangular position and with uterus intracaecal with respect to the anterior loops of the intestinal caeca. The equatorial position of the acetabulum in *U. dasylophi* and *U. icteri* separate these species from *U. turdi.* The greater ratio of acetabulum to oral sucker separates *U. dasylophi* from *U. icteri.*

Urogonimus turdi (Yamaguti, 1939) new comb.

Leucochloridium turdi Yamaguti, 1939: 184.

This species found in the cloaca of *Turdus cardis cardis* in Japan is closely related to *U. parcus* (Travassos), *U. icteri* (McIntosh), and *U. dasylophi* (Tubangui). The course of the uterus is not too well defined in

Yamaguti's figure; however, the diagnosis of the species states that the ascending and descending branches of the uterus cross dorsal to the acetabulum in median field. I believe that these uterine loops are that part of the uterus which descends and loops around the acetabulum and ascends again to the area of the pharynx before turning and terminating at the genital pore.

One may speculate whether *L. cardis* with a linear arrangement of the genital glands is not a variation of *U. turdi*, since worms of the two species were found together in the same host. As stated previously, in natural infections of *L. dryobatae* from Song Sparrows, specimens with linear arrangement of the genital glands and specimens with the ovary displaced to one side in triangular position were found living together in the cloaca. The ovary is smaller than the testes in *U. turdi*, whereas the ovary is larger than the testes in *U. cardis*. *U. turdi* is further distinguished from *U. cardis* by the arrangement of the genital glands. The slight post-equatorial position of the acetabulum separates *U. turdi* from the other species in the genus. These differences are of sufficient significance for the differentiation of these species.

UROGONIMUS sp. Lutz, sp. inquirenda

Urogonimus sp. Lutz, 1921: 136; Viana, 1924: 148. *Leucochloridium* sp. Travassos, 1928: 364.

This species reported by Lutz from *Passer domesticus* in Brazil is represented in the literature by a photomicrograph of a whole mount. The short vitellaria and the gap between the anterior loops of the uterus lead me to place this species in *Urogonimus*. The arrangement of the genital glands with the ovary to one side shows an affinity with *U. parcus* (Travassos) and *U. icteri* (McIntosh). For lack of adequate description this species is considered to be a *species inquirenda*.

UROGONIMUS MESOSTOMUS (Rudolphi, 1803) sp. dubia

Fasciola mesostoma Rudolphi, 1803: 28. *Distoma mesostomum* Rudolphi, 1809: 387; 1819: 104; Braun, 1901: 466. *Brachylaemus mesostomus* Dollfus, 1935: 67. (non) *Distoma mesostomum* Diesing, 1850: 361 (= *D. turdi* Rud., 1819); Zeller, 1874: 573; Stossich, 1890: 43; 1892: 7 (= *D. loxia* Rud., 1819); 1896: 128. (non) *Harmostomum mestostomum* Braun, 1902: 116-117; 126-129; Witenberg, 1925: 206; Dollfus, 1935: 68.

Fasciola mesostoma from the large intestine of *Turdus iliacus* was reported by Rudolphi (1803). His characterization is very brief and does not contain a description of the cirrus. However, he pointed out that this species of *D. macrostomum* were so very similar that had he been able to see the cirrus of *D. mesostomum* he would not have described a new species Diesing (1850) in addition to the host reported by Rudolphi added *Pyrrhula vulgaris*, *Fringilla coccothraustes* and *Fringilla chloris* as hosts and reduced *D. turdi* Rud., 1819, to synonymy with Rudolphi's species. *D. turdi* is designated as *species dubia* by Rudolphi (1819) and has never been described. A species with genital pore opening between the acetabulum and oral sucker recovered from *Turdus iliacus* and *T. merula* and obviously not the *D. mesostomum* of Rudolphi with terminal genital pore, was never-

theless designated as *D. mesostomum* Rud. by Zeller (1874). Stossich (1890) also in error designated a Brachylaemus sp. from *Turdus viscivorous* as *D. mesostomum* Rud. He (1896) recovered from *Columba livia* another Brachylaemus sp. which he designated as *D. mesostomum* Rud.

Braun (1902) restudied specimens of this species on deposit in the Berlin and Vienna Museums. One specimen of the four originally reported by Rudolphi (1803) was present in the Berlin collection, but was in such a faded condition that Braun could only measure its length, width, and the size of egg. Nothing of the internal morphology of the specimen was described. Diesing's material of which there were specimens from *Pyrrhula vulgaris* and *Fringilla coccothraustes* were found to contain specimens synonymous with *U. macrostomus* (Rud.) in the former case, and an undescribed species of Harmostome in the latter. Braun redescribed the species from *Fringilla coccothraustes* as *Harmostomum mesostomum* (Rud.) Another specimen from *Pyrrhocorax alpinus* designated as *D. caudale* Rud. by Diesing was found to be synonymous with the *D. mesostomum* of Diesing. Stossich's species were restudied and identified as *Harmostomum fuscatum* Rud.

One reason why Braun may have discarded Rudolphi's specific designation of *D. macrostomum* and *D. mesostomum* is the possibility that he may have overlooked that Rudolphi was describing the cirrus of the specimen, and not the cirrus sac, for Braun interpreted Rudolphi's statement "das Kügelchen des Schwanzendes" to mean the cirrus sac instead of the cirrus.

Stiles (1901) in a discussion on nomenclature as applied to parasites stated that if early synonymy cannot be clearly demonstrated from a modern point of view an action on the part of the early worker designating similarity and relationship is evidence enough for supporting such relationships. At the turn of the century one specimen upon which Rudolphi based his original description of this species was still available in the Berlin Museum (No. 1505). Since Braun did not recognize the significance of the arrangement of the genital glands one does not know whether he overlooked the arrangement of these organs or found them beyond recognition. On the basis of Rudolphi's statements of its relationship to *D. macrostomum*, I believe that *D. mesostomum* Rud., 1803 should remain in the genus as *species dubia*. Since *Harmostomum mesostomum* is a homonym of *Urogonimus mesostomus* (Rudolphi) the former name is not available. Rudolphi's type material of *D. mesostomum* should be restudied and when it is properly described, the specimens Diesing deposited and designated by Braun as *Harmostomum mesostomum* should be renamed.

Dollfus (1935) recognized Braun's synonymy of Diesing's specimens but following Joyeux and Foley (1930) he adopted the generic designation of *Brachylaemus mestostomum* (Rud.). *D. mesostomum* reported in the host lists of Wolffhuegel (1900) and Hausmann (1899) were reduced by Dollfus to synonymy with *B. fuscatus auctorum*. *H.* (*H.*) *fuscatum* (Rudolphi)

and *H.* (*H.*) *inflatocoelum* Witenberg he reduced to synonymy with *Brachylaemus mesostomum*. *D. mesostomum* Rud. referred by Dollfus to the genus *Brachylaemus* should be designated as *Brachylaemus mesostomum* (Diesing).

Genus LEUCOCHLORIDIUM Carus, 1835

Leucochloridium Carus, 1835: 85-100.

The genus *Leucochloridium* was established by Carus (1835) for a green and white sporocyst found by him in *Succinea amphibia*. The unique nature of this colored sporocyst invoked much interest in Europe, but it was not until Zeller (1874) fed sporocysts of *L. paradoxum* to passerine birds and recovered adults that the significance of these colored sporocysts was well established. Zeller identified his species as *D. macrostomum* Rud., 1803. A comparison of the sporocyst used by Zeller and that described by Carus is not conclusive because the author's figures and these sporocysts are not too clear and the description of the sporocyst in Zeller's paper is that of a young immature broodsac that "sechzehn Tage später war die Farbung in ihre ganzen Schönheit vorhanden." Hsü (1936) working in Germany collected and described a green and white broodsac which developed into an adult very similar to Zeller's species in *Pavoncella pugnax*, Sparrows, and a Canary. Hsü's description of the broodsac found in *S. putris*, a synonym of *S. amphibia*, agrees very closely with the description of Carus's broodsac. The three broodsacs described by Carus (1835), Zeller (1874) and Hsü (1936) were reported from Germany and from the same snail host. In my opinion these workers described the same species of broodsac. Since the mature worm described by Hsü and Zeller are similar, and the broodsac described by Hsü and Carus are similar, *L. macrostomum* of Zeller should be designated as *L. paradoxum* Carus, the name used by Carus for the larval stage which he described.

The first to attempt life cycle studies in this genus was Von Siebold (1853), who found a green broodsac near Breslau, Germany, and correlated the metacercaria on the basis of comparative morphology with *D. holostomum* Rud., a distome taken by him from birds of the family Rallidae. Unable to obtain birds of the family Rallidae, he fed the broodsacs to frogs and reported negative results. The initial success of Zeller (1874) with the feeding of green broodsacs and recovery of adult distomes in passerine birds, was followed by the classical life history study of Heckert (1889). The latter worked out several of the stages of the cycle, establishing the fact that in order to hatch, the egg had to be eaten by the snail. He presented also a detailed study of the development of the sporocyst in the snail and of the adult distome in the bird. Heckert, unable to infect older birds, stressed the importance of infecting young nestlings, believing that the older birds were refractory to the infection.

Witenberg (1925), on the basis of host specificity, placed species of this genus in synonymy with species that are recognized in this revision as belonging to separate genera. He recognized that Heckert's and Zeller's species from passerine birds were related to one of his species from shore-

birds, but resolved that difficulty by placing the former among *species dubiae*. Witenberg's supposition that a strict host specificity exists among the species or the genus *Leucochloridium* was proved incorrect by Hsü (1936) whose feeding experiments established experimentally that green broodsacs when fed to short birds and songbirds develop into the same species. By infecting a 3-year-old canary, he established the falsity of Heckert's hypothesis that only young birds were able to become infected. I, too, have been able to infect mature birds.

Hohorst (1937), in a nontechnical description of the life cycle of an undesignated species of this genus, reported that the metacercaria from a brown broodsac developed in a canary. The photomicrograph reproduced by him figures a three-day specimen that I believe to be a metacercaria which had resisted digestion and was recovered undeveloped from the intestine. It is highly significant that the cirrus of this European species is identical with the cirrus of American species in this genus, for the only other cirrus figured in the literature for the European species of this genus is that of Zeller's species which differs from that of the American species.

In the United States, McIntosh and McIntosh (1939) reported that green broodsacs resembling those described by Woodhead (1935) when fed to a Starling developed into *L. actitis* McIntosh. The McIntosh specimens have been examined by me and are similar to those recovered in my feeding experiments with green broodsacs. Eggs dissected from a specimen identified as *L. cyanocittae* (*L. actitis*) McIntosh from a Red Wing Blackbird and fed by me to laboratory-raised *Oxyloma retusa* (*Succinea retusa*) resulted in an infection with a green broodsac identical with green broodsacs collected in the field. Bennett (1942) reported that green broodsacs collected in Louisiana when fed to several species of birds, *Gallus domesticus*, *Passer domesticus* and *Agelaius phoeniceus* developed into *L. actitis* McIntosh. Robinson (1947) fed a brown and white broodsac from *S. ovalis* to *Passer domesticus* and recovered *L. fuscostriatum* Robinson. This experiment is important because it demonstrates that metacercariae from other than green broodsacs develop into adults of this genus.

The criteria adopted for differentiating species within the genus are the anterior and posterior extension of the vitellaria and their relation to the intestinal caeca; position of the genital pore; relationship of the uterine loops to the intestinal caeca and oral sucker; and relative size of oral sucker to acetabulum. Hsü used as species characters the posterior extension of the vitellaria and the relationship of the uterine loops and the vitellaria to the intestinal caeca. The validity of some of these characters listed above and used by me in this diagnosis is open to question on the basis of a limited number of feeding experiments conducted in my study (Kagan, 1951). Results that should be weighed carefully in light of the limited number of feeding experiments with green broodsacs from a single snail to several types of bird hosts indicate that a host-parasite relationship may affect the extent of the vitellaria. In other experimental infections with red-brown broodsacs

the extent of the vitellaria of *Neoleucochloridium problematicum* (Magath) is influenced by the host. The limited number of specimens recovered in the experiments with green broodsacs suggests the need for further study before the conclusions stated before can be applied to a revision of the species of the genus.

McIntosh (1927, 1932) based specific determinations on such characters as distance between anterior testis and ovary, size of ovary as compared to that of the pharynx, and other characters subject to variation caused by pressure or growth of the worm. Size of the ovary has been found in my studies to vary considerably from host to host fed on broodsacs from a single snail. Hsü (1936) reported similar results in his studies.

Many of the type species in this genus have been characterized from pressed specimens. In the preparation of specimens of soft-bodied animals, such as trematodes, for determination of species, they should not be subjected to pressure in order to make the organs more readily visible. Distances between organs in animals so treated and the size of soft organs, as testes and ovary, may be considerably changed by pressure. Coverglass pressures are not measured and cannot be duplicated by other workers. The distortions produced by pressure give false impressions of size and of the spatial relationships between organs.

Genus LEUCOCHLORIDIUM Carus, 1835 emend.

Generic diagnosis.—Leucochloridiinae: Body elliptical. Acetabulum and oral sucker well developed, muscular. Cuticula spinose or aspinose. Genital pore terminal or subterminal. Excretory pore opening close to genital pore. Laurer's canal opening into excretory bladder. Uterus ascending to level of oral sucker and passing over to other side of body between acetabulum and pharynx; metraterm glandular, thin-walled. Cirrus pouch large, muscular. Cirrus long, smooth or slightly spinose, tapering to a point. Genital glands in triangular configuration. Seminal receptacle present. Vitellaria extending to end of intestinal caeca or to terminal part of body. Parasites in digestive tract of passerine and shore birds.

Type species: Leucochloridium paradoxum Carus, 1835 (= *D. macrostomum* of Zeller (1874), *L.* sp. Hsü, 1936, from *Pavoncella pugnax*).

Additional species: L. heckerti sp. nov. (= *L.* sp. Hsü, 1936, from *Vanellus vanellus*, *L. insigne* of Witenberg (1925)); *L. australiense* Johnston and Simpson, 1940; *L. sime* Yamaguti, 1935; *L. melospizae* McIntosh, 1932; *L. variae* McIntosh, 1932; *L. passeri* Wu, 1938; *L. musculare* Wu, 1938; *L. cyanocittae* McIntosh, 1932; *L. fuscostriatum* Robinson, 1947; *L.* sp. Hohorst, 1937 sp. inq.; *L.* sp. Stossich, 1896 sp. inq.

LEUCOCHLORIDIUM PARADOXUM Carus, 1835 [= *D. macrostomum* of Zeller (1874)]

Leucochloridium macrostomum of Zeller, 1874: 564-578; Szidat, 1936: 646. *Leucochloridium* sp. Hsü, 1936: 714 (from *Pavoncella pugnax*).

The literature of species described as *L. macrostomum* (Rud.) has been reviewed in the discussion on *Urogonimus macrostomus* (Rud.) Since Zeller's figure of the distome recovered by him from his experimental in-

fections has appeared widely in the literature, other species may have been described as *L. macrostomum* that are similar to this species.

On the basis of the posterior extent of the vitellaria the European species from this genus may be separated into two groups: those with vitellaria extending to the terminal portion of the body and those with vitellaria extending but little beyond the ends of the intestinal caeca. In *L. paradoxum* the vitellaria overlap, and terminate slightly beyond, the ends of the intestinal caeca, leaving a wide gap between the vitelline branches. Hsü (1936) in Germany described an un-named species from *Pavoncella pugnax* that is so similar morphologically to *L. paradoxum* that I believe these species are synonymous. The species from the Kamphläufer (*Pavoncella pugnax*) was recovered from natural infections and obtained experimentally from the same host, from *Passer domesticus* and *Serinus canaria*. Hsü believed this species to be closely related to Witenberg's species. I cannot agree with Hsü because the vitellaria in Witenberg's species terminate very close to one another in the hinder part of the body, "wo sie manchmal zusammenschliessen." In Hsü's species there is a large gap between the vitellaria. Hsü's species from the Kamphläufer is similar to Zeller's species in the extension of the vitelline masses and their overlapping of the intestinal caeca.

L. melospizae McIntosh is another species closely related to *L. paradoxum*. McIntosh (1932) differentiated these species on the relative size of the genital organs; smaller in *melospizae* and larger *in paradoxum*. These characters may not prove to be significant, but because of geographical separation and differences in the known broodsacs from these two continents, I believe that these species are distinct.

Leucochloridium heckerti sp. nov.

Distomum macrostomum Heckert, 1889: 1-66; Szidat, 1936: 646. *Leucochloridium* sp. Hsü, 1936: 714 (from *Vanellus vanellus*). *Leucochloridium insigne* Witenberg, 1925: 240; Szidat, 1936: 651.

Szidat (1936) and Hsü (1936) pointed out that the species designated by Heckert as *D. macrostomum* Rud. was not identical with the species described by Zeller (1874) as *D. macrostomum* Rud. and that neither was identical with the species described by Rudolphi (1803) as *D. macrostomum*. The life cycle of *L. heckerti*, renamed in honor of Heckert, involves a green broodsac with a red-brown tip speckled with red pigmented protuberances. The broodsac differs from the green and white broodsac with a light brown tip and black-brown pigmented protuberances described by Carus, Zeller and Hsü. In morphology the adult distomes differ in the extent of the vitellaria, which extend to the terminal part of the body in *L. heckerti*, and end just beyond the tip of the intestinal caeca in *L. pardoxum*.

Closely related to this species are the species described by Hsü (1936) from the Kiebitz, *Vanellus vanellus*, and a species designated as *L. insigne* (Looss) by Witenberg (1925).

Witenberg took his species from shorebirds and identified them as *L.*

insigne (Looss, 1899). Although he recognized that his species differed in many respects from the species described by Looss, he believed that Looss had not adequately characterized *L. insigne* thus accounting for many of the differences between the species. Witenberg's species and Looss's species are not congeneric.

A critical appraisal of the specimens figured by Witenberg from *Actitis hypoleucos* shows decided variation in the size of the ovary with respect to the testes and in the character and disposition of the vitellaria. In his fig. 11, the ovary is larger than the testes and the vitellaria are represented as fine follicles; in his fig. 10, the ovary is smaller than the testes and the vitellaria are composed of coarse follicles; in his fig. 12, the genital glands are very small and the vitellaria resemble those shown in fig. 10. Szidat (1936) believed that Witenberg was dealing with more than one species. Further experimental work is needed before the variations figured by Witenberg as normal for the species can be determined to be valid for separating them into two or more species.

In his diagnosis Witenberg used average measurements of 4 specimens. These measurements closely approximate the specimen figured in his fig. 10 and therefore, I am assuming that these measurements and his figure provide the basis for his species which I consider to be morphologically similar to *L. heckerti* and therefore reduce to synonymy with the latter.

The species described by Hsü from the Kiebitz (*Vanellus vanellus*) was differentiated from another species recovered from the Kamphläufer (*Paroncella pugnax*) by Hsü (1936) mainly on the arrangement of the vitellaria. A free translation of Hsü's statement reads: "In specimens from the Kiebitz the vitellaria show a seemingly dense arrangement and extend almost completely to the hind end of the body and overlap only slightly the outside rim of the intestinal caeca. Specimens from the Kamphläufer have loosely packed follicles, the vitellaria masses are separated in the posterior portion of the body by a considerable gap and they overlap the intestinal caeca." Hsü stated that this species is closely related to Heckert's species, renamed *L. heckerti* sp. nov., and *L. sime* Yamaguti, from Japan. I believe Hsü's species is synonymous with *L. heckerti*, but because *L. sime* is from another continent, I think it unwise at present to reduce Hsü's species to synonymy with *L. sime* until the larval stages of *L. sime* are described and figured.

L. variae McIntosh, an American species, is also closely related to *L. heckerti*. For reasons stated previously, I consider these two species distinct.

LEUCOCHLORIDIUM sp. Hohorst, 1937 sp. inquirenda

Leucochloridium sp. Hohorst, 1937: 122.

Hohorst in pictorial fashion depicted the life cycle of a species that very closely resembles *L. heckerti* sp. nov. The cirrus of this European species is similar to that depicted by McIntosh for *L. actitis*, an American species, and the similarity in other respects between *L. actitis* and Hohorst's species is very striking. The broodsacs reported by Hohorst as a green type from

S. putris were not described, nor figured in color. A photograph of the broodsac shows encircling bands of pigment with pustules on the tip. Without information on the nature of the color of the tip of the broodsac and the color of the postules one cannot determine with certainty whether this broodsac is similar to that described by Heckert. Until the broodsac is properly described and a specific diagnosis of the species written, this species must be considered as a *species inquirenda*.

LEUCOCHLORIDIUM SPECIES FROM NORTH AMERICA

McIntosh (1932) described *L. actitis, L. cyanocittae, L. pricei, L. variae,* and *L. melospizae* from birds in Michigan. Robinson (1947) described *L. fuscostriatum* from an experimental infection in *Passer domesticus*.

The position of the genital pore, either terminal or subterminal, separates the American species into two groups. Species with a terminal genital pore are *L. fuscostriatum* Robinson, *L. actitis* McIntosh, and *L. cyanocittae* McIntosh. The life cycle of *L. fuscostriatum* involves a brown banded broodsac from *S. ovallis,* while that of *L. actitis* involves a green banded sporocyst from *Oxyloma retusa*. In *L. fuscostriatum* the vitellaria are very broad and overlap the intestinal caeca whereas, in *L. actitis* and *L. cyanocittae* the vitellaria are extracaecal. McIntosh separated *L. cyanocittae* from *L. actitis* on the basis of the larger size of the body, suckers and pharynx, and the greater distance separating the anterior testis from the ovary. These differences are not thought to be valid criteria for separating these two species and *L. actitis* is therefore reduced to synonymy with *L. cyanocittae* on the basis of page priority of the latter.

The species with genital pore subterminal are *L. pricei* McIntosh, *L. variae* McIntosh, and *L. melospizae* McIntosh. In *L. melospizae* the vitellaria are loosely packed and terminate near the end of the intestinal caeca, whereas, in *L. pricei* and *L. variae,* the vitellaria extend further posteriad into the region of the cirrus sac. McIntosh separated *L. pricei* from the other species in the genus on the basis of the median position of the ovary and testis. A series of cotypes on deposits in the U. S. National Museum shows that the median position is not a constant character and therefore *L. pricei* is reduced to synonymy with *L. variae* on the basis of page priority of the latter.

LEUCOCHLORIDIUM SPECIES FROM ASIA

Three species from this genus have been described from Asia: *L. musculare* Wu (1938) and *L. passeri* Wu (1938) from China, and *L. sime* Yamaguti (1935) from Japan. *L. musculare* Wu possesses a terminal genital pore and vitellaria that do not terminate near the cirrus pouch but slightly beyond the end of the intestinal caeca; *L. passeri* and *L. sime* have a subterminal genital pore, but the latter differs in that in it the vitellaria extend to the terminal portion of the body. *L. sime* is closely related to *L. insigne* of Witenberg, *L. heckerti* sp. nov., and *L. variae* McIntosh and to *L.* sp. Hsü from the Kiebitz designated by Hsü (1936) as *L.* sp. (*sime* Yamaguti

1934?). Yamaguti stated that *L. sime* "is most closely related to *L. variae* McIntosh 1932 but differs from it in the relative size of the oral and ventral suckers."

The absence of comparative life history studies and of specimens for comparative studies deters me from reducing these species to synonymy. Life history stages of Leucochloridium have not been described from the snails of Japan. On morphological grounds, *L. heckerti, L. variae,* and *L. sime* cannot be differentiated from one another and appear in the same line in the key to the known species of the genus *Leucochloridium.*

LEUCOCHLORIDIUM SPECIES FROM AUSTRALIA

Only one adult species (*Leucochloridium australiense*) has been described from the birds of Australia; however, reports that more than one kind of broodsac occurs there suggests that probably other species exist on that continent. *L. australiense* Johnston and Simpson, 1940 is closely related to *L. paradoxum, L. melospizae* and *L. passeri* in the posterior extension of the vitelline masses, but differs in that the vitellaria are extracaecal while in the other species the vitellaria overlap the intestinal caeca. The anatomical details of the adult *L. australiense* agree very closely with those of the American species. Laurer's canal opens into the excretory bladder as in the American species. The apparent similarity of the species in this genus makes it very difficult to key them out. The only significant difference in species from separate continents is the color of the broodsac. Until it can be shown that the color of the broodsac is of no specific value these species are considered to be distinct from one another.

Genus **Neoleucochloridium** Gen. Nov.

The first species to be characterized in this genus was *D. holostomum* from *Rallus aquaticus* by Rudolphi (1819). A second species, *Urogonimus cercatus,* was described by Monticelli (1893), based on a specimen deposited in the British Museum without any host data. Monticelli made several errors in his diagnosis, mistaking the cirrus for a tail and the posterior testis for the ovary. Nevertheless, his figure is very good and the terminal portion of the distome as well as the cirrus with its pustules is enlarged in separate drawings. Looss (1896) recognized that Monticelli was in error in believing that this species had a tail and he discounted the pustulated cirrus by stating that the pustules were artifacts caused by improper preservation. *U. cercatus* Monticelli was believed by Witenberg (1925) and Szidat (1936) to be similar to *D. holostomum* Rud.

Urogonimus insignis was described by Looss (1899) from *Fulica atra,* the Coot, in Egypt. The equatorial position of the ventral sucker and lack of spination separate this species from the other species of the genus. Szidat (1936) believed *U. insignis* to be a young stage of *D. holostomum* based on the fact that the uterus is not in gravid condition. I agree with Szidat's

opinion, and can support his statement that during development the younger distomes have the acetabulum in equatorial position and that only with increased size and maturity does the acetabulum assume a pre-equatorial position.

Solowiow (1912) described *Urogonimus turanicus* in Russia from *Totanus glareola*. In her generic description, she too described "little warts" on the cirrus. Solowiow separated her species from *U. macrostomus* (Rud.), *U. insignis* Looss, *U. cercatus* Monticelli and *U. rossittensis* Mühling on the basis of the presence of cuticular spines and the position of the acetabulum, and of the position of the genital pore which she, probably in error, claimed to open on the ventral surface.

Magath (1920) reported *L. problematicum*, a red-brown broodsac in Iowa, and suggested that it may be the larval stage of *U. insignis* Looss. He noticed that the Laurer's canal of the encysted metacercaria opened into the excretory bladder. Looss (1899), although he did not see the actual connection of Laurer's canal with the bladder in his sectioned material of *U. insignis*, nevertheless stated that he was certain that it did so empty. Probably it was this morphological similarity between the two organisms that brought Magath to his idea of relationship between these two species.

Lutz (1921) in Brazil may have reported two species from this genus: one in *Parra jacana* with a genital complex similar to *N. holostomum* and *N. problematicum* (*L. sorae* McIntosh) and another in *Gallinula galeata* similar to *N. flavum* (Travassos, 1922). Lutz published no more than a photomicrograph of these species. Travassos (1922) in Brazil recovered a distome from *Gallinula galeata* which he named *Leucochloridium flavum* and which he stated was similar to the distome recovered by Lutz. He fed the eggs to the snail, *Homalonyx unguis*, and 50 days later recovered the orange-brown broodsac earlier reported by Lutz (1921).

Witenberg (1925) in his monograph on the Harmostominae synonymized *U. insignis* Looss with species of the genus *Leucochloridium*. He recognized *L. turanicum* (Solowiow) as a valid species and described several other specimens as *L. turanicum* from *Crex pratensis, Porzana maruetta, Rallus aquaticus* and *Upopa epops*. *Distomum holostomum* (Rud.) and *Urogonimus cercatus* Monticelli were placed by him in the category of *species dubiae*. The specimens figured by him from *Crex pratensis* show affinity with *D. holostomum* Rud. while the specimens figured from *Upopa epops* show affinity with *N. hypotaenidarium* (Tubangui, 1932).

McIntosh (1927) reported *L. sorae*, a species from the United States from the Sora Rail, *Porzana carolina*. Baylis (1928) in England reported a species from *Rallus aquaticus* as *L. macrostomum* Rud. On the basis of host specificity demonstrated by these genera I believe that Baylis' species is probably a member of the genus *Neoleucochloridium*. Tubangui (1932) reported, from the Philippine Islands, *N. hypotaenidiarum* new comb. from *Hypotaenidia striata* and *Turnix fasciata*. Szidat (1936) redescribed Rudolphi's original specimens of *D. holostomum* on deposit in the Berlin

Museum. Larios (1943) in Mexico reported a species, *L. insigne* (Looss), from the Blue Wing Teal, *Querquedula discors*.

The species of this genus are separated on the bases of morphological and life history characters. The relative size of ovary and testes in the gravid distome, the pre-equatorial or post-equatorial position of the acetabulum, lobation of testes, and relationship of uterus and vitellaria to the intestinal caeca form the bases for the morphological separation of sexually mature adults. The nature of the pigmented broodsac forms the basis for separation on life history characters.

Life history studies have been conducted by Travassos (1922) with the orange-brown sporocyst from *Homalonyx unguis* which developed into *N. flavum* (Travassos, 1922), and with the red-brown broodsac that develops into *N. problematicum* (Magath) Kagan (1951).

Genus Neoleucochloridium gen. nov.

Generic diagnosis.—Leucochloridiinae: Distomes elongate, rounded at both ends. Suckers large and well developed. Cuticle spinose or aspinose. Prepharynx small, pharynx large, intestinal caeca reaching to hind end of body. Excretory pore, dorsal. Excretory bladder simple, muscular. Uterus intracaecal, circling the acetabulum in short loops, opening subterminally; metraterm, muscular; terminal portion of uterus richly endowed with gland cells. Genital pore subterminal. Cirrus pouch large, muscular, well developed. Cirrus long, smooth, pustulated. Testes and ovary in triangular position. Receptaculum seminis present. Laurer's canal long, opening into excretory bladder. Vitellaria well developed, extracaecal. Parasites in digestive tract of bird.

Type species: Neoleucochloridium problematicum (Magath, 1920) (= *L. sorae* McIntosh, 1927) new comb.

Additional species: N. flavum (Travassos, 1922) new comb., *N. hypotaenidiarum* (Tubangui, 1932) new comb., *N. holostomum* (Rudolphi, 1819) new comb., *N. japonicum* (Ishii, 1933) sp. inquirenda.

Neoleucochloridium holostomum (Rudolphi, 1819) new comb.

Distoma holostomum Rudolphi, 1819: 94, 368; Dujardin, 1845: 445; Von Siebold, 1848: 121; 1853: 433; Diesing, 1850: 339; 1858: 277; Cobbold, 1861: 11; Walter, 1866: 64; Lutz, 1921: 136; Szidat, 1936: 650; Witenberg, 1925: 243. (non) *Distoma macrostomum* Zeller, 1874: 574. (non) (*Dicrocoelium*) *holostomum Rud.*, Parona, 1896: 2. (non) *Cladocoelium holostomum* Stossich, 1892: 3. (non) *Urogonimus macrostomus* Braun, 1901: 565; 1902: 136.

Rudolphi (1819) in the following diagnosis translated from the Latin described *D. holostomum* as follows: "Bremser sent me a specimen found in the intestine of *Rallus aquaticus*, most elegant specimen, 1½ lines long, ½ line wide. Suckers very large, oral sucker round, acetabulum large with elliptical crosswise aperture. Body oblong, broader toward the front, tapering to the back, posterior apex rather obtuse; dorsum arched, venter flat. Intestine to side obscured; ovary in middle of length. A very distinct species."

Dujardin (1845) in a French translation of Rudolphi's diagnosis reported the size of the distome as 3.37 mm long and 1.12 mm wide. Von Siebold (1848) reported the species from two additional hosts, *Gallinula chloropus* and *Gallinula porzana*, and noted that the cirrus of *D. holostomum* was pustulated. Diesing (1850) reduced *D. ralli* Rud., 1819 sp. dubiae to synonymy with *D. holostomum* of Rud. Von Siebold (1853) in an excellent monograph on *L. parodoxum* Carus, the green and white broodsac from Europe, erroneously believed that the larval stages studied by him developed into *D. holostomum* Rud. Cobbold (1861) reported this species from two hosts, *Rallus aquaticus* and *Crex porzana* and overlooked the third host reported by Von Siebold. Walter (1866) reported a distome as *D. holostomum* Rud. from *Rallus aquaticus* with dendritic intestinal caeca. This must have been either an error in interpretation of anatomical detail or he had a worm from another family. Zeller (1874) borrowed several of Von Siebold's drawings and after comparing them with his species, came to the erroneous conclusion that *D. holostomum* Rud. was synonymous with *D. macrostomum* Rud. for the only difference of significance to him was the larger size of the former. He dismissed this difference as of no importance because he noticed that, depending on the host used in his feeding experiments, *D. macrostomum* varied in size, and that, therefore, the large size of *D. holostomum* was a result of host influence and not a specific difference. Stossich (1892) raised the subgenus *Cladocoelium* to generic rank for those distomes with dendritic intestinal caeca and included this species along with *D. gigantium* and *D. hepaticum* in that genus.

Parona (1896) reported 2 specimens of *D.* (*Dicrocoelium*) *holostomum* in the collection of the University of Torino in Italy from *Sterna hirundo*, stating, "che pero assegno con qualche dubbio a questa specie, tuttavia poco conosciuto." Braun (1901, 1902) re-examined Rudolphi's original material on deposit in the Berlin and Vienna Museums and came to the same conclusion as Zeller that outside of size differences, *D. holostomum* Rud. was synonymous with *D. macrostomum* Rud. As stated earlier, Lutz (1921) suggested that *D. macrostomum* Rud. was in reality two species, *D. macrostomum* Rud. and *D. holostomum* Rud. He also believed that *U. cercatus* Monticelli and *U. insignis* Looss were very similar to *D. holostomum* Rud. Witenberg (1925) also separated *D. holostomum* Rud. from *D. macrostomum* Rud. on the basis of host specificity since the former was reported from a swamp bird and the latter from a song bird. Witenberg recognized *U. turanicum* Solowiow as a valid species and suggested that *D. holostomum* Rud., *U. cercatus* Mont., and *U. insignis* Looss and Magath's *L. problematicum* were synonyms of *U. turanicus* Solowiow.

Szidat (1936) pointed out that, in addition to the difference in size between *D. holostomum* Rud. and *D. macrostomum* Rud., as reported by Zeller and Braun, other fundamental differences were apparent, such as the arrangement of the genital glands which are in trianular position in the former and in tandem in the latter; the considerable distance between the

anterior testis and the acetabulum in the former and often non-existent in the latter; the uterine loops confined with the intestinal caeca in *D. holostomum,* and overlapping the intestinal caeca in *D. macrostomum;* and the anterior end of the vitellaria which never extend anterior to the bend in the intestinal caeca in *D. holostomum,* but extend beyond that bend in *D. macrostomum.* Szidat (1936) also reduced the earlier species, *U. turanicus, U. cercatus,* and *U. insignis* to synonymy with *D. holostomum.* A comparison of these distomes as reported in the literature seems to confirm Szidat's synonymy.

N. holostomum (Rud.) appears to be identical with *N. problematicum* (Magath) from this country and is keyed out to the same place in the key. However, the species are not reduced to synonymy because of the differences of the larval stages of European and American species.

Neoleucochloridium problematicum (Magath, 1920) new comb.

Leucochloridium problematicum Magath, 1920: 105-114. *Leucochloridium sorae* McIntosh, 1927: 359-361.

The life cycle reported by me in another paper points out that the broodsacs described by Magath (1920) and by Woodhead (1935) develop into *L. sorae* McIntosh, 1927. However, *L. sorae* McIntosh falls as a synonym of *N. problematicum* (Magath, 1920) new comb.

The specimens described by McIntosh (1927) as *L. sorae* are young worms, smaller than those taken by McIntosh (not published) from another Sora Rail at Washington, D. C., and smaller than specimens taken by me from a Gallinule in the Lake Erie Marshes. Specimens obtained when red-brown broodsacs were fed to Coots, Gallinules and Rails are identical with specimens recovered in natural infections.

N. problematicum is separated from the other species in the genus in that the testes are smooth in relaxed specimens; the caeca separate the uterine loops from the vitellaria; the ovary is smaller than the testes; and the species develops from red-brown broodsacs described by both Magath (1920) and Woodhead (1935).

Neoleucochloridium flavum (Travassos, 1922) new comb.

Urogonimus sp. Lutz, 1921: 136. *Leucochloridium flavum* Travassos, 1922: 257; 1928: 366; Viana, 1924: 118, 148. *Leucochloridium insigne* Larios, 1943: 499.

This species was reported by Lutz (1921) from *Gallinula galeata* in Brazil and was described by Travassos (1922, 1928) when he completed its life cycle. There seems to be a discrepancy between the diagnosis of the species given in 1922 and in 1928 by Travassos for in 1922 the length of the distome was reported to be 3.5 mm. and in 1928, 5.0-7.5 mm. With the exception of egg size, stated to be 0.025 by 0.017 mm. in 1922, and 0.027 by 0.017 mm. in 1928, all other measurements are similar. The life

cycle involves the orange-brown sporocyst reported by Lutz (1921). Travassos (1922) reported that in experimental infections with snails the orange-brown broodsac developed to maturity in 50 days.

N. flavum (Travassos) is distinguished from *N. problematicum* (Magath) and *N. holostomum* (Rud.) by the loosely packed vitelline follicles, the uterine loops which overlap the intestinal caeca, and the testes which are very large in comparison to the ovary and are deeply lobed. In *N. problematicum* the vitellaria are extracaecal or overlap the margins of the intestinal caeca, but are separated from the uterine loops by the intestinal caeca, and the testes are entire unless made slightly lobate by coverslip pressure.

Ignacio Larios (1943) in Mexico reported a species from *Querquedula discors* as *L. insigne* (Looss). In his species the acetabulum is equatorial, but in the relationship of the vitellaria and the uterine loops to the intestinal caeca and the relative size and lobation of the genital glands, his species is similar to *N. flavum* (Travassos). *L. insigne* of Larios is believed to be a synonym of *N. flavum* (Travassos).

Neoleucochloridium hypotaenidiarum (Tubangui, 1932) new comb.

Leucochloridium hypotaenidiarum Tubangui, 1932: 380; McIntosh, 1932: 53.

This species, reported by Tubangui (1932) in the Philippine Islands from *Hypotaenidia striata* and *Turnix fasciata* is very closely related to *N. holostomum* (Rud.) and *N. problematicum* (Magath). The species is believed to be distinct from the other species in the genus because the ovary is larger than the testes and the vitellaria overlap the intestinal caeca. The ovary in young specimens of *N. problematicum* is for a time slightly larger than the testes but in the mature fully grown adult distome they are always smaller. The species reported by Witenberg (1925) from *Upopa epops* appears to be similar to *N. hypotaenidiarum* and may be conspecific with it.

NEOLEUCOCHLORIDIUM JAPONICUM (Ishii, 1933) sp. inquirenda

Leucochloridium japonicum Ishii, 1933: 96.

N. japonicum (Ishii), the first species of Leucochloridiinae to be described in Japan, was found in the intestine of the copper pheasant. The precise position of this species in the recognized genera of this subfamily is difficult to determine because of the brevity of the specific diagnosis and the lack of detail in the figure. The short vitellaria show affinities with *U. turdi, U. dasylophi,* and *U. icteri,* and led me to believe that perhaps this species may belong in the genus *Urogonimus.* However, the intracaecal uterus and the host in which it was found led me to place this species in this genus as a *sp. inquirenda.*

It seems possible that shortness of vitellaria in *japonicum* may result

from development in the copper pheasant which may not be the usual host. The vitellaria of adults of *N. problematicum*, when developed experimentally in chickens, have short vitelline fields terminating near the end of the intestinal caeca. In comparison, vitellaria extend into the area of the cirrus sac in distomes experimentally reared in Coots, Rails, and Gallinules.

The diagnosis of *N. japonicum* gives no clue to the nature of the cirrus. This species may be separated from the other species of the genus because of the post-equatorial position of the acetabulum.

DISCUSSION OF GENERA

The genera *Urogonimus* Monticelli, 1888; *Urotocus* Looss, *Leucochloridium* Carus, 1835, and *Neoleucochloridium* gen. nov. in the subfamily Leucochloridiinae Poche, 1907 may be divided into two groups. *Urotocus is* closely related to *Urogonimus* and differs mainly in that the organs of attachment are drastically reduced. *Neoleucochloridium* is closely related to *Leucochloridium* and is separated from the latter on the character of the cirrus and the intracaecal nature of the uterine loops.

Leucochloridium and *Neoleucochloridium* differ from *Urogonimus* and *Urotocus* in the arrangement of the uterine loops which in the former pass between the pharynx and the acetabulum instead of around the posterior edge of the acetabulum; Laurer's canal in *Leucochloridium* and *Neoleucochloridium* opens into the excretory bladder instead of to the dorsal surface; the cirrus in *Leucochloridium* is long and pointed, in *Neoleucochloridium* long and pustulated; whereas, in *Urogonimus* and *Urotrichus* the cirrus is short and stubby.

Species of *Urogonimus* and *Urotocus* and species in the subfamily Brachylaeminae Joyeux and Foley, 1930, possess the following characteristics in common: short vitelline fields, Laurer's canal opening to the dorsal surface, genital glands in line and cirrus short and bulbous. Life histories are known only for the genera *Leucochloridium* and *Neoleucochloridium*. The possibility exists that the elucidation of life histories in *Urogonimus* and *Urotocus* may show that these genera may be properly placed in the subfamily Brachylaeminae, as was done for the genus *Panopistus* Sinitsin, 1931.

Host specificities demonstrated in the subfamily Leucochloridiinae show that species of *Neoleucochloridium* parasitize the more primitive orders of birds. Specimens of *Neoleucochloridium* have been taken from birds in the orders Anseriformes, Galliformes, Gruiformes, Charadriiformes and Coraciiformes. However several species parasitize both passerine birds and shore birds in the order Charadriiformes. One species, *L. variae* McIntosh, reported by Mueller as *L. pricei*, was taken from a bird in the order Galliformes. Species of *Urogonimus* are with two exceptions, viz. *U. dasylophi* Tubangui taken from a Cuckoo in the Philippine Islands and *U. caryocatactis* from a bird in the Coraciidae, parasites of birds of the orders Piciformes and Pas-

seriformes. The known species of the genus *Urotocus* are parasites of birds of the order Passeriformes. On the basis of host specificity *Neoleucochloridium* appears to be the most primitive genus followed by *Leucocochloridium* and finally by *Urogonimus* and *Urotocus*.

The color and pattern of the broodsacs in this subfamily are accepted as good characters for the separation of species. Geographic separation of very similar species and lack of life history data have made the designation of valid species very difficult. Since it is far easier to reduce species to synonymy than to separate them once they are reduced to synonymy, species from different continents that appear to be similar were not reduced to synonymy because of the differences in the larval stages from these continents reported in the literature. The possibility that the color pattern and color of the broodsac may not be of genetic significance, but a result of the influence of the host on the parasite, was considered and rejected because in the snail, *Oxyloma retusa*, 4 types of broodsacs have been reported of various colors and patterns. Moreover, multiple infections with green and brown broodsacs, known to develop into different species, have been reported in the literature and I have collected the red-brown broodsac in two genera of Succineid snails (Kagan, 1949).

The characters used in the separation of species in the genera, *Leucochloridium* and *Urogonimus* need further experimental studies to determine their validity.

KEY TO THE GENERA OF LEUCOCHLORIDIINAE

1. A. Body elongate; suckers weakly developed ..... *Urotocus*
   B. Body elliptical, oblong or oval; suckers large 2
2. A. Vitellaria short, extending to level of posterior testis. Uterus does not circle acetabulum. Cirrus short and stubby ..... *Urogonimus*
   B. Vitellaria extending to hind end of body. Uterus circling acetabulum passing between acetabulum and pharynx. Genital glands forming a triangle 3
3. A. Uterus extracaecal. Cirrus long and narrow, smooth or spinose ..... *Leucochloridium*
   B. Uterus intracaecal. Cirrus long and pustulated ..... *Neoleucochloridium*

KEY TO KNOWN SPECIES OF UROGONIMUS

1. A. Genital glands in tandem 2
   B. Genital glands in triangular position 9
2. A. Acetabulum equatorial 3
   B. Acetabulum post-equatorial ..... *U. cardis*
3. A. Uterus extending into area of pharynx and oral sucker 4
   B. Uterus intracaecal ..... *U. seiuri*
4. A. Genital glands occupying most of area between posterior rim of acetabulum and tip of body 6
   B. Genital glands occupying only small part of area between acetabulum and tip of body 5
5. A. Vitellaria extend to level of ovary ..... *U. vireonis*
   B. Vitellaria extend beyond ovary ..... *U. caryocatactis*
6. A. Ovary equal to or larger than testes, occasionally slightly smaller than testes 7

B. Ovary much smaller than testes 8

7. A. Uterine loops extend into area of oral sucker ..... *U. dryobatae*
B. Uterine loops limited to area of pharynx and slightly overlapping posterior margin of oral sucker ..... *U. macrostomus*

8. A. Ovary less than half as large as testes ..... *U. certhiae; U. witenbergi*
B. Ovary approaching size of testes, but never larger than testes ..... *U. mniotiltae; U. witenbergiella*

9. A. Acetabulum equatorial 10
B. Acetabulum post-equatorial ..... *U. turdi*

10. A. Uterine loops extend into area of pharynx and oral sucker 11
B. Uterine loops limited by intestinal caeca to area below pharynx 12

11 A. Vitellaria overlapping intestinal caeca ..... *U. vireonis*
B. Vitellaria not overlapping intestinal caeca ..... *U. parcus*

12. A. Acetabulum slightly larger than oral sucker ..... *U. icteri*
B. Acetabulum much larger than oral sucker ..... *U. dasylophi*

KEY TO KNOWN SPECIES OF LEUCOCHLORIDIUM

1. A. Genital pore terminal 2
B. Genital pore subterminal 4

2. A. Vitellaria extend posteriorly to area of cirrus pouch 3
B. Vitellaria terminate at level of intestinal caeca ..... *L. musculare*

3. A. Vitellaria extracaecal or overlap edge of intestinal caeca ..... *L. cyanocittae*
B. Vitellaria overlapping intestinal caeca completely ..... *L. fuscostriatum*

4. A. Vitellaria terminate at level of intestinal caeca 5
B. Vitellaria extending into area of cirrus pouch ..... *L. sime; L. variae; L. heckerti*

5. A. Vitellaria overlapping intestinal caeca 6
B. Vitellaria extracaecal ..... *L. australiense*

6. A. Oral sucker smaller than acetabulum ..... *L. passeri*
B. Oral sucker larger than acetabulum ..... *L. melospizae; L. paradoxum*

KEY TO KNOWN SPECIES OF NEOLEUCOCHLORIDIUM

1. A. Acetabulum pre-equatorial 2
B. Acetabulum post-equatorial ..... N. *japonicum*

2. A. Vitellaria separated from uterine loops by intestinal caeca. Testes entire in relaxed specimens, slightly lobate in pressed specimens. Ovary smaller than testes in mature distomes ..... *N. holostomum; N. problematicum*
B. Vitellaria and uterine loops overlapping intestinal caeca 3

3. A. Testes lobate and much larger than ovary ..... *N. flavum*
B. Testes smooth; ovary slightly larger than testes in full grown adults ..... *N. hypotaenidiarum*

KEY TO KNOWN SPECIES OF UROTOCUS

1. A. Acetabulum present ..... *U. rossittensis*
B. Acetabulum absent ..... *U. fusiformis*

List of Hosts for Species of Neoleucochloridium (Leucochloridiinae)*

N. holostomum (Rud., 1819)		
Rallus aquaticus	Germany	Rudolphi (1819)
"Gallinula porzana" (Porzana porzana)	Germany	Von Siebold (1848)
Gallinula chloropus	Germany	Von Siebold (1848)
"Crex porzana" (Porzana porzana)	Europe	Cobbold (1861)
Fulica atra	Egypt	Looss (1899)
"Crex pratensis" (Crex crex)	Don Basin, Russia	Witenberg (1925)
"Porzana maruetta" (Porzana porzana)	Don Basin, Russia	Witenberg (1925)
Sterna hirundo	Italy	Parona (1896)
"Totanus glareola" (Tringa glareola)	Turkestan, Russia	Sololiow (1912)
N. problematicum (Magath, 1920)		
Porzana carolina	Minnesota, USA	McIntosh (1927)
Fulica americana	Michigan, USA	Kagan (1951)
Gallinula chloropus	Michigan, USA	Kagan (1951)
Rallus limicola	Michigan, USA	Kagan (1951)
Gallus domesticus	Michigan, USA	Kagan (1951)
N. hypotaenidiarum (Tubangui, 1932)		
"Hypotaenidia striata" (Rallus striatus)	Philippine Islands	Tubangui (1932)
"Turnix fasciata" (Turnix suscitator)	Philippine Islands	Tubangui (1932)
Upupa epops	Don Basin, Russia	Witenberg (1925)
N. flavum (Travassos, 1922)		
"Gallinula galeata" (Gallinula chloropus)	Brazil	Travassos (1922)
"Parra jacana" (Jacana spinosa)	Brazil	Lutz (1921)
"Querquedula discors" (Anas discors)	Mexico	Larios (1943)
Porzana albicollis	Brazil	Lutz (1921)
Porphyrula martinica	Brazil	Lutz (1921)
N. japonicum (Ishii, 1933) sp. inq.		
"Graphophasianus soemmerringii scintillans" (Syrmaticus soemmerringii scintillans)	Japan	Ishii (1933)

* Synonyms of many of the host species reported in the early literature were provided by Dr. J. Van Tyne, Museum of Zoology, University of Michigan, Ann Arbor.

List of Hosts for Species of Leucochloridium (Leucochloridiinae)

L. paradoxum Carus, 1835 (*D. macrostomum* of Zeller)		
"Rothkehlchen" (Erithacus rubecula)	Germany	Zeller (1874)
"Curruca garrula" (Sylvia curruca)	Germany	Zeller (1874)
"Schwartzkopfchen" (Sylvia atricapilla)	Germany	Zeller (1874)
Motacilla sp.	Germany	Zeller (1874)
"Pavoncella pugnax" (Philomachus pugnax)	Prussia, Germany	Hsü (1936)
Passer domesticus	Prussia, Germany	Hsü (1936)
Serinus canaria	Prussia, Germany	Hsü (1936)
L. heckerti sp. nov. (*D. macrostomum* of Heckert)		
"Phyllopneuste sylvicola" (Phylloscopus sibilatrix)	Germany	Heckert (1889)
"Sylvia garrula" (Sylvia curruca)	Germany	Heckert (1889)
"Sylvia cinerea" (Sylvia communis)	Germany	Heckert (1889)
Passer domesticus	Germany	Heckert (1889)
Sitta europaea	Germany	Heckert (1889)
Vanellus vanellus	Prussia, Germany	Hsü (1936)
Actitis hypoleucos	Don Basin, Russia	Witenberg (1925)
"Totanus ochropus" (Tringa ochropus)	Turkestan, Russia	Witenberg (1925)
"Totanus glareola" (Tringa glareola)	Don Basin, Russia	Witenberg (1925)
L. australiense Johnston and Simpson, 1940		
"Pomatostomus superciliosus" (Pomatorhinus superciliosus)	Australia	Johnston and Simpson (1940)
Corcorax melanorhamphos	Australia	Johnston and Simpson (1940)
L. sime Yamaguti, 1935		
Coccothraustes coccothraustes japonicus	Japan	Yamaguti (1935)
L. melospizae McIntosh, 1932		
"Melospiza melodia beata" (Melospiza melodia euphonia)	Michigan, USA	McIntosh (1932)

List of Hosts for Species of Leucochloridium (*continued*)

L. variae McIntosh, 1932		
Mniotilta varia	Michigan, USA	McIntosh (1932)
Canachites canadensis osgoodi	Alaska	McIntosh (1932)
Bonasa umbellus	New Hampshire, USA	Mueller (1941)
Turdus migratorius	Moran, Wyoming	Rausch (unpublished)
L. passeri Wu, 1938		
Passer montanus taivanensis	Canton, China	Wu (1938)
L. muscularae Wu, 1938		
Passer montanus taivanensis	Canton, China	Wu (1938)
L. fuscostriatus Roginson, 1947		
Passer domesticus	New York, USA	Robinson (1947)
L. cyanocittae McIntosh, 1932		
Cyanocitta cristata bromia	Michigan, USA	McIntosh (1932)
Actitis macularia	Michigan, USA	McIntosh (1932)
Agelaius phoeniceus	Louisiana, USA	Bennett (1942)
Passer domesticus	Louisiana, USA	Bennett (1942)
Passerina cyanea	Michigan, USA	E. L. Cheatum (unpublished)
Empidonax traillii	Michigan, USA	E. L. Cheatum (unpublished)
Totanus flavipes	Michigan, USA	E. L. Cheatum (unpublished)
Serinus canaria	Michigan, USA	Kagan (1951)
Telmatodytes palustris (Cistothorus palustris)	Michigan, USA	Kagan (1951)
Sturnus vulgaris	Washington, D.C.	McIntosh & McIntosh (1939)
L. sp. Hohorst, 1937		
Acrocephalus scirpaceus scirpaceus	Germany	Hohorst (1937)
Sylvia borin borin	Germany	Hohorst (1937)
Serinus canaria	Germany	Hohorst (1937)

List of Hosts for Species of uncertain generic position but reported in the literature as *D. macrostomum* Rud., *L. macrostomum* and *U. macrostomus* Rud. (Leucochloridiinae)

Motacilla flava	Germany	Rudolphi (1819)
"Motacilla cinerea" (Sylvia cinerea)	Germany	Rudolphi (1819)
"Motacilla nisoria" (Sylvia nisoria)	Germany	Rudolphi (1819)
"Motacilla passerina" (Sylvia borin)	Germany	Dujardin (1845)
Thoryotorus hypoxanthus (?)	Germany	Creplin (1851)
"Picus major" (Dendrocopos major)	Germany	Schlotthauber (1860)
"Picus medius" (Dendrocopos medius)	Germany	Schlotthauber (1860)
Parus palustris	Germany	Rudolphi (1819)
"Parus pendulinus" (Anthoscopus pendulinus)	Germany	Rudolphi (1819)
"Fringilla linaria" (Acanthis linaria)	Germany	Rudolphi (1819)
"Pyrrhula vulgaris" (Pyrrhula pyrrhula)	Germany	Diesing (1850)
Passer domesticus	Germany	Mühling (1898)
Corvus corone	Germany	Hausmann (1899)
Garrulus glandarius	Germany	Hausmann (1899)
Numenius tenuirostris	Trieste	Stossich (1896)
Dryocopus martius	Germany	Hausmann (1899)
Turdus auritus	Poland	Kowalewski (1902)
"Totanus glareola" (Tringa glareola)	Russia	Skrjabin (1913)
Sturnus vulgaris	Scotland	Ritchie (1916)
Lanius excubitor	Scotland	Ritchie (1916)
Turdus merula	Switzerland	André (1917)
Spinus spinus	Russia	Skrjabin and Massino (1925)
"Luscinia philomela" (Luscinia luscinia)	Russia	Skrjabin and Massino (1925)
"Phylloscopus atricapilla" (Sylvia atricapilla)	Russia	Skrjabin and Massino (1925)
Erithacus rubecula	Russia	Skrjabin and Massino (1925)
Dendrocopos major	Russia	Skrjabin and Massino (1925)
Corvus cornix	Germany	Korkhaus (1935)
Corvus frugilegus	Germany	Korkhaus (1935)
Emberiza hortulana	Russia	Solonitsyn (1928)
Emberiza sp.	Russia	Solonitsyn (1928)
Oriolus glandarius	Russia	Solonitsyn (1928)
Hirundo rustica	Russia	Solonitsyn (1928)
Muscicapa striata	Russia	Shtrohm (1935)

Muscicapa striata	Russia	Solonitsyn (1928) Shtrohm (1935)

List of Hosts for Species of Urotocus and Urogonimus (Leucochloridiinae)

	Genus UROTOCUS	
U. rossittensis (Mühling, 1898)		
Turdus pilaris	Germany	Mühling (1898)
U. fusiformis McIntosh, 1935		
Oporornis philadelphia	Washington, D.C.	McIntosh (1935)
Geothlypis trichas	Washington, D.C.	McIntosh (1935)
Dendroica magnolia	Washington, D.C.	McIntosh (1935)
	Genus UROGONIMUS	
U. macrostomus (Rudolphi, 1803)		
"Motacilla luscinia" (Luscinia luscinia)	Germany	Rudolphi (1803)
"Picus tridactylus" (Picoides tridactylus)	Germany	Rudolphi (1819)
U. caryocatactis (Zeder, 1800)		
Nucifraga caryocatactes	Germany	Zeder (1800)
"Pyrrhocoracis glandarius" (Garrulus glandarius)	Germany	Rudolphi (1819)
Coracias garrulus	Germany	Mueller (1897)
U. witenbergiella sp. nov. (*L. macrostomum* of Witenberg)		
Alauda arvensis	Moskow, Russia	Witenberg (1925)
Turdus musicus	Don Basin, Russia	Witenberg (1925)
Turdus pilaris	Nowotscherkask, Russia	Witenberg (1925)
"Turdus iliacus" (Turdus musicus)	Nowotscherkask, Russia	Witenberg (1925)
Turdus merula	Moskow, Russia	Witenberg (1925)
Parus major	Moskow, Russia	Witenberg (1925)
Fringilla coelebs	Moskow, Russia	Witenberg (1925)
"Anthus obscurus" (Anthus spinoletta obscurus)	Faeroe Islands	Bovien (1932)

List of Hosts for Species of Urogonimus (*continued*)

U. witenbergi Skrjabin, 1948 (*L.* sp. of Witenberg)		
"Muscicapa grisola" (Muscicapa striata)	Buchara, Russia	Witenberg (1925)
U. seiuri (McIntosh, 1932)		
Seiurus aurocapillus	Michigan, USA	McIntosh (1932)
U. dryobatae (McIntosh, 1932)		
"Dryobates villosus" (Dendrocopos villosus)	Michigan, USA	McIntosh (1932)
Sphyrapicus varius varius	Michigan, USA	McIntosh (1932)
Pipilo e. erythrophthalmus	Michigan, USA	McIntosh (1932)
"Piranga erythromelas" (Piranga olivacea)	Michigan, USA	McIntosh (1932)
"Vireosylva olivacea" (Vireo olivacea)	Michigan, USA	McIntosh (1932)
Molothrus ater ater	Michigan, USA	McIntosh (1932)
Regulus satrapa satrapa	Madison, Wisconsin	Rausch (unpublished)
Spizella pusilla pusilla	Ann Arbor, Michigan	Cheatum (unpublished)
Carpodacus purpureus	Virginia, USA	Reynolds (1936)
U. certhiae (McIntosh, 1927)		
Certhia familiaris americana	Minnesota, USA	McIntosh (1927)
"Melospiza melodia beata" (Melospiza melodia euphonia)	Michigan, USA	McIntosh (1927)
Dendroica castanea	Washington, D.C.	McIntosh (1935)
Sphyrapicus varius	Washington, D.C.	McIntosh (1935)
U. mniotiltae (McIntosh, 1927)		
Mniotilta varia	Minnesota, USA	McIntosh (1927)
Oporornis agilis	Washington, D.C.	McIntosh (1935)
U. icteri (McIntosh, 1927)		
Icterus galbula	Minnesota, USA	McIntosh (1927)

List of Hosts for Species of Urogonimus (*continued*)

U. vireonis (McIntosh, 1927)		
Vireo griseus griseus	Mississippi, USA	McIntosh (1927)
Telmatodytes palustris (Cistothorus palustris)	Michigan, USA	Cheatum (unpublished)
U. parcus (Travassos, 1922)		
Ostinops decumanus	Brazil	Travassos (1922)
Tachyphonus cristatus brunneus	Brazil	Travassos (1922)
U. dasylophi (Tubangui, 1928)		
Dasylophus superciliosus	Philippine Islands	Tubangui (1928)
U. turdi (Yamaguti, 1939)		
Turdus cardis cardis	Japan	Yamaguti (1939)
U. cardis (Yamaguti,, 1939)		
Turdus cardis cardis	Japan	Yamaguti (1939)
U. sp. Lutz, 1921		
Passer domesticus	Brazil	Lutz (1921)
U. mesostomum (Rudolphi, 1803)		
"Turdus iliacus" (Turdus musicus)	Germany	Rudolphi (1803)
"Fringilla chloris" (Chloris chloris)	Germany	Creplin (1849)
"Fringilla pyrrhula" (Pyrrhula pyrrhula)	Germany	Creplin (1849)
Turdus merula	Germany	Wolffheugal (1900)
"Coccothraustes vulgaris" (Coccothraustes coracillium)	Germany	Wolfheugal (1900)
"Loxia coccothraustes" (Coccothraustes coccothraustes)	Germany	Rudolphi (1803)
"Loxia chloris" (Chloris chloris)	Germany	Rudolphi (1803)
"Loxia pyrrhula" (Pyrrhula pyrrhula)	Germany	Rudolphi (1803)

SUMMARY

The subfamily Leucochloridiinae Poche, 1907 has been emended to include the genera *Urotocus* Looss, 1899, *Urogonimus* Monticelli, 1888, *Leucochloridium* Carus, 1835, and *Neoleucochloridium* gen. nov. On the basis of morphology and life history studies, the genera *Panopistus* Sinitzin, 1931 and *Urorygma* Braun, 1901 have been excluded from the subfamily.

The genus *Leucochloridium* Carus has been divided into three genera on the basis of comparative morphology of the adults; into the genera *Leucochloridium* Carus, *Urogonimus* Monticelli, and *Neoleucochloridium* gen. nov. *Urogonimus* Monticelli, 1888 is validated and removed from synonymy with *Leucochloridium* Carus, 1835.

The genus *Leucochloridium* Carus, 1835 is characterized by having the genital glands in a triangular arrangement; cirrus, long, pointed, smooth or spinose; uterus circling the acetabulum; Laurer's canal opening into the excretory bladder. The type species is *L. paradoxum* Carus, 1835.

The genus *Neoleucochloridium* gen. nov. is characterized by having a triangular arrangement of the genital glands; cirrus, long, pustulated; the forward extension of the uterine loops always intracaecal; Laurer's canal opening into the excretory bladder. The type species is *N. problematicum* (Magath, 1920) new comb. (=*L. sorae* McIntosh).

The genus *Urogonimus* Monticelli, 1888 is characterized by having the genital glands in linear or triangular arrangement; cirrus, short and stubby; uterus not circling the acttabulum, but looping back around the posterior rim of the acetabulum; Laurer's canal opening separately on the dorsal surface. The type species is *Urogonimus macrostomus* (Rud., 1803) new comb.

The genus *Urotocus* Looss, 1899 is characterized by having a linear arrangement of the genital glands; cirrus, short and stubby; uterus intracaecal; suckers poorly developed. The type species is *Urotocus rossittensis* (Mühling, 1898).

Ten species are recognized in the genus *Leucochloridium*, 14 species in *Urogonimus*, five species in *Neoleucochloridium*, and two species in *Urotocus*.

The following species formerly placed in synonymy with *U. macrostomus* (Rud., 1803) have been found to be different and distinct and have been renamed: (a) *U. witenbergiella* sp. nov. (*L. macrostomum* of Witenberg, 1925), (b) *L. paradoxum* Carus, 1835 (*D. macrostomum* of Zeller, 1874), (c) *L. heckerti* sp. nov. (*D. macrostomum* of Heckert, 1889), (d) *U. caryocatactis* (Zeder, 1800) (*D. caudale* Rudolphi, 1809, *D. caudale* of Mueller, 1898).

The designation of Diesing's species, *D. caudale* Rud. and *D. mesostomum* Rud. as *Harmostomum caudale* (Rud.) and *Harmostomum mesostomum* (Rud.) by Braun (1902) have been shown to be in error. *Harmostomum caudale* has been renamed *Brachylaemus brauni*.

The following species have been reduced to synonymy: (a) *L. insigne* of Witenberg with *L. heckerti* sp. nov., (b) *L.* sp. Hsü from *Pavoncella pugnax* with *L. paradoxum* Carus, (c) *L* sp. Hsü from *Vanellus vanellus*

with *L. heckerti* sp. nov., (d) *L. actitis* McIntosh with *L. cyanocittae* McIntosh, (e) *L. pricei* McIntosh with *L. variae* McIntosh.

The type specimens of *U. icteri* and *U. vireonis* were restudied and the position of the genital pore shown to be terminal instead of subterminal, Laurer's canal to open on the dorsal surface and the uterine loops to follow a pattern typical for the genus *Urogonimus*.

Hosts reported for the species of the subfamily Leucochloridiinae have been listed and the nomenclature brought up to date.

Keys for the separation of the known species of the subfamily have been constructed.

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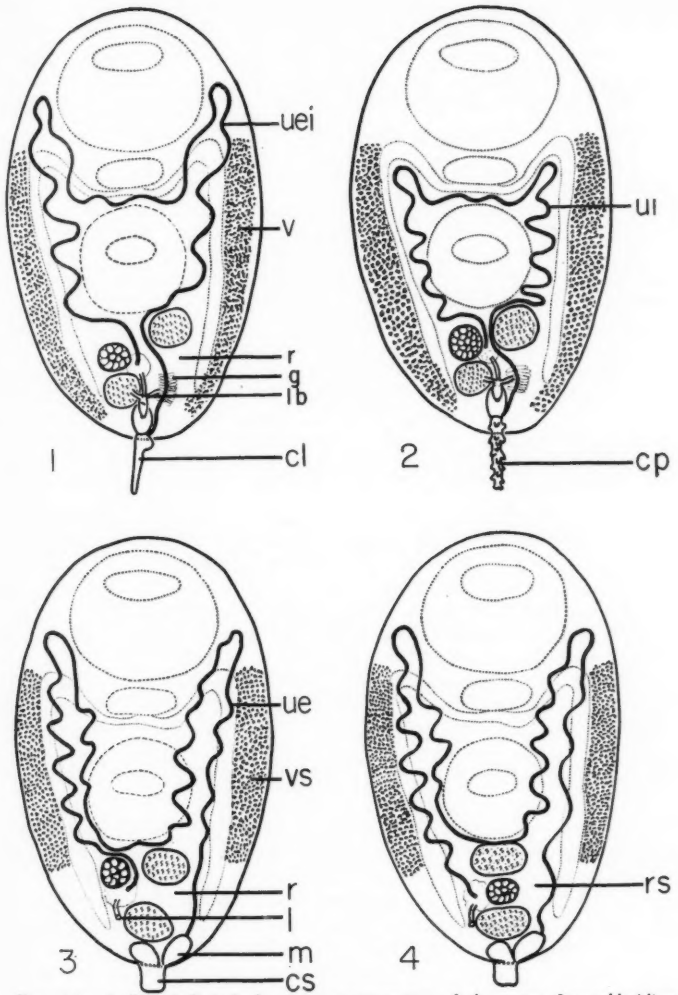

Figs. 1-4.—1. Morphological characters representative of the genus *Leucochloridium* Carus, 1835. 2. Morphological characters distinguishing the genus *Neoleucochloridium* gen. nov. 3. Morphological characters which characterize the genus *Urogonimus* Monticelli, 1888. 4. Other variation of the reproductive organs in the genus *Urogonimus*.

ABBREVIATIONS: cp—Cirrus pustulate; cl—Cirrus long, smooth and pointed; cs—Cirrus short and bulbous; g—Gland cells surrounding terminal portion of uterus; l—Laurer's canal opening to dorsal surface of body; lb—Laurer's canal opening into excretory bladder; m—Metraterm bulbous; r—Reproductive glands in triangular configuration; rs—Reproducing glands in straight line; ue—Uterus extracaecal, crossing body behind acetabulum; uei—Uterus extracaecal, crossing body in front of acetabulum; ui—Uterus intracaecal, crossing body in front of acetabulum; v—Vitellaria extending to posterior part of body; vs—Vitellaria short. All figures are diagrammatic and were drawn freehand.

The Aquatic Hemiptera of Southeastern Louisiana (Exclusive of the Corixidae)[1]

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The abundance of aquatic Hemiptera throughout North America long ago attracted the attention of many entomologists. Their studies have resulted in several monographs on the taxonomy and distribution of these insects which, although presenting a mass of data on distribution, have necessarily failed to include many specific records from Louisiana or any other state. Thus, species collected in given localities regarded as typical of larger geographical regions have often been considered as occurring throughout this larger region. Studies of the ecological zoogeography of the various species within smaller areas such as individual states or parts of them have been comparatively few. In the South the only local study of aquatic Hemiptera has been that of Millspaugh (1939) in the Dallas, Texas area.

Previously published records of aquatic Hemiptera in Louisiana are comparatively meager. The earliest record was Say's description of *Hydrometra australis* in 1859 with New Orleans as the type locality, and up to 1917 only twelve speices had been recorded from Louisiana. In Van Duzee's (1917) checklist these twelve are *Hydrometra martini, H. australis, Gerris remigis, Notonecta uhleri, N. undulata, Pelocoris femoratus, Ranatra nigra, Benacus griseus, Lethocerus uhleri, Belostoma flumineum, B. lutarium* and *Trepobates pictus*. Records of twenty-four additional species (including the Corixidae) were found in the literature from 1918 to 1949, making a total of thirty-six species. The new records added in this study increase to fifty-eight the number of species of aquatic Hemiptera known to occur in Louisiana.

The species herein recorded from Louisiana for the first time include the following twenty-two species: *Ranatra fusca edentula, Gelastocoris oculatus, Hydrometra myrae, Buenoa scimitra, B. elegans, B. limnocastoris, Plea striola, Velia watsoni, V. brachialis, Microvelia americana, M. borealis, M. atrata, M. hinei, Mesovelia amoena, Gerris nebularis, G. marginatus, G. argenticolis, Metrobates hesperius, Rheumatobates hungerfordi, Trepobates subnitidus, Belostoma testaceum,* and *B. bakeri*. Two additional species without Louisiana records, but included because the state apparently falls within their respective ranges, are *Gelastocoris variegatus* and *Pelocoris carolinensis*.

The unique geographic position of Louisiana warrants a more intensive study of the species found there. The state is situated so that there is the

1 A contribution from the Department of Zoology of the Tulane University of Louisiana, New Orleans; one of a series of reports resulting from researches on *Mosquitoes and Other Aquatic Insects* supported by the Tulane University Council on Research.

possibility of an overlapping of the ranges of eastern and western Nearctic species as well as some of Neotropical origin. This study thus establishes a basis for more detailed studies in the future along these lines, and may also be of some value in studying limnological and fisheries problems in the state.

MATERIAL STUDIED

All material included in this study was that already present in the Tulane University collections in addition to that collected by the author and members of the Tulane staff from 1947 to 1949. Specimens from the U. S. National Museum were also used for comparison in the identification of certain groups, but no state records were added from this source. The Corixidae were omitted from this study because of their confused taxonomy when the study was begun; these difficulties have been cleared away by Hungerford's monograph on the family which was published in late 1948, too late to incorporate the family in this paper.

AREA STUDIED

Collections were primarily from the southeastern section of Louisiana, including twenty-eight parishes which make up roughly one-third of the total area of the state (fig. 1). The area is rather diversified in topography and includes a variety of ecologically distinct habitat types ranging from the Pleistocene terraces northward to the lowlands and fresh and brackish marshes southward to the coast. The highest lands of the terraces have a rolling surface, many small sand-bottomed creeks and local pineland sloughs throughout. This region is primarily one of longleaf, loblolly and shortleaf pine.

The lowland marshes range from fresh to salt water with degrees of salinity existing as geographical and seasonal variations. This area has a very low surface with much of it frequently below the water table. The alluvial bottom lands, also included here, are formed primarily from the Mississippi River and its distributaries. The land is typically higher in elevation and of coarser soil near the rivers and bayous (natural levees), becoming lower in elevation and finer in texture the greater the distance from the river. For a good detailed description of this area see Holland (1944).

METHODS AND TECHNICS

Collecting methods and technics were kept as simple as possible for convenient travel and rapid collecting over large areas. Most specimens of aquatic Hemiptera were most easily taken with dip nets although a few were taken with a minnow seine. During the winter months successful collecting was dependent on muddying the bottom muck and debris to stir up the inactive insects before attempting to dip them.

All specimens were killed immediately and preserved in 70% alcohol, and pinned later in the laboratory. In addition to the routine records of locality, date, time, collector and habitat, appropriate habitat factors were checked off on a convenient standard field-data card for each collection. Aquatic plants present at each collecting site were identified by sight. Thus only the genus was recorded in most cases; nomenclature of plants follows that of Muenscher (1944).

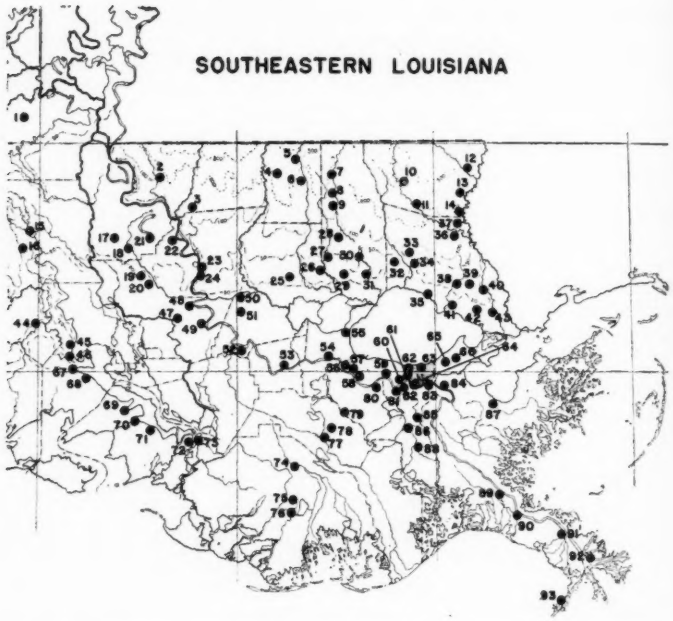

Fig. 1.—Distribution of localities in southeastern Louisiana from which aquatic Hemiptera were collected. Numbers represent localities and parishes (in parentheses) as follows: Alford (West Baton Rouge)—22, Algiers (Orleans)—83, Ama (St. Charles)—80, Amite (Tangipahoa)—9, Arcola (Tangipahoa)—8, Audubon Park (Orleans)—64, Avondale (Jefferson)—82, Bains (West Feliciana)—2, Baldwin (St. Mary)—69, Baptist (Tangipahoa)—27, Barataria (Jefferson)—86, Baton Rouge (East Baton Rouge)—23, Bayou Goula (Iberville)—49, Berwick (St. Mary)—72, Bogalusa (Washington)—13, Bonnet Carré Spillway (St. Charles)—56, Boudreaux (Terrebonne)—75, Boutte (St. Charles)—80, Bridgedale (Jefferson)—60, Bucktown (Jefferson)—62, Burrwood (Plaquemines)—93, Bush (St. Tammany)—36, Centerville (St. Mary)—71, Chalmette (St. Bernard)—84, City Park (Orleans)—63; Colyell (Livingston)—25, Covington (St. Tammany)—34, Crown Point (Jefferson)—85, Darlington (St. Helena)—4, Delta National Wildlife Refuge (Plaquemines)—92, DeFeleice (Plaquemines)—90, Des Allemands (St. Charles)—79, Donaldsonville (Ascension)—52, Dulac (Terrebonne)—76, Dutchtown (Ascension)—51, Enon (Washington)—11, Florenville (St. Tammany)—39, Fontainebleau State Park (St. Tammany)—35, Fordoche (Pointe Coupee)—17, Fort Jackson (Plaquemines)—91, Franklin (St. Mary)—70, Franklington (Washington)—10, Frenier (St. John)—55, Goodbee (St. Tammany)—32, Greensburg (St. Helena)—6, Grosse Tete (Iberville)—20, Hester (St. James)—53, Hickory (St. Tammany)—40, Hope Villa (Ascension)—50, Houma (Terrebonne)—74, Indian Village (Iberville)—47, Indian Village (St. Tammany)—43, Kenner (Jefferson)—59, Keystone (St. Martin)—46, Lacombe (St. Tammany)—41, Lafayette (Lafayette)—44, Lafitte (Jefferson)—88, Lake Clause (West Baton Rouge)—22, Lakeland (Pointe Coupee)—21, Lee (Orleans)—65, Lindsay (East Feliciana)—3, Liverpool (St. Helena)—5, Marksville (Avoyelles)—1, Metairie (Jefferson)—62, Micheaud (Orleans)—66, Montz (St.

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I would like to thank Dr. Reece I. Sailer through whose courtesy specimens from the U. S. National Museum were obtained for comparison, and for determining the Gerridae; and, to Dr. D. Warren Craik of Howard College for checking determinations of several species of *Belostoma;* and, Mr. Frederick A. Truxal at the University of Kansas for checking determination of the *Buenoa.*

SYSTEMATIC TREATMENT

In devising the tentative key for Louisiana species free use has been made of the larger more comprehensive keys in various publications. These included the keys by Blatchley (1926), Cummings (1933), Herring (1948), Hungerford (1922, 1933), La Rivers (1948), Parshley (1921) and Torre Bueno (1911, 1924).

In the following treatment of each species, each lot number denotes an individual collection of one or more individuals, and one or more species. Abbreviations for collectors' names are: GHP = George H. Penn, GHB = George H. Bick, ESH = Edward S. Hathaway, LLE = Leslie L. Ellis, JFA = James F. Aycock, TFH = Thomas F. Hall, and JVB = John V. Baus.

TENTATIVE KEY TO THE SPECIES OF AQUATIC HEMIPTERA OF LOUISIANA, EXCLUSIVE OF THE CORIXIDAE

1. Antennae shorter than head, usually contained in a concavity below the eyes 2
   Antennae as long or longer than head, exposed 24
2. Body surface warty; not strictly aquatic, living on beaches and shores (Gelastocoridae) 3
   Body surface smooth 4
3. Width of head (face) on a line below the ventral margin of eyes greater than length ..... *Gelastocoris oculatus* (p. 310)
   Width of head less than length ..... *Gelastocoris variegatus* (p. 311)
4. Hind tarsi with two distinct claws 5
   Hind tarsi without distinct claws 18
5. Membrane of hemelytra without veins (Naucoridae) 6
   Membrane of hemelytra with veins, reticulate 7
6. Median lobe of sixth ventral plate deeply notched at apex, notch twice as deep as wide; male dorsal aedeagal plate truncate at tip ..... *Pelocoris carolinensis* (p. 317)
   Median lobe of sixth ventral plate weakly notched at apex; male dorsal aedeagal plate emarginate at tip ..... *Pelocoris femoratus* (p. 316)

Charles)—56, Morgan City (St. Mary)—73, New Iberia (Iberia)—67, New Orleans (Orleans)—63, 64, Norco (St. Charles)—57, Olivier (Iberia)—68, Opelousas (St. Landry)—16, Pearl River (St. Tammany)—40, Plaquemine (Iberville)—48, Ponchatoula (Tangipahoa)—29, Ponchatoula Beach (Tangipahoa)—31, Port Sulphur (Plaquemines)—89, Raceland (Lafourche)—77, Ramsay (St. Tammany)—33, Reserve (St. John)—54, Rio (Washington)—14, Robert (Tangipahoa)—30, Rosedale (Iberville)—19, Roseland (Tangipahoa)—8, Roux (Lafourche)—78, Slidell (St. Tammany)—42, Southport (Jefferson)—61, Springfield (Livingston)—26, St. Martinville (St. Martin)—45, St. Rose (St. Charles)—58, St. Tammany (St. Tammany)—38, Sun (St. Tammany)—37, Tangipahoa (Tangipahoa)—7, Tickfaw (Tangipahoa)—28, University (East Baton Rouge)—24, Valverda (Pointe Coupee)—18, Varnado (Washington)—12, Waggaman (Jefferson)—81, Washington (St. Landry)—15, Yscloskey (St. Bernard)—87.

7. Apical appendages of the abdomen tube-like, long and narrow, non-retractile (Nepidae) 8
Apical appendages of the abdomen flat, short and retractile (Belostomatidae) 12
8. Body elongate, elliptical in shape; prothorax broader than head; siphon shorter than abdomen ..... *Curicta drakei* (p. 308)
Body long and subcylindrical in shape; prothorax narrower than head; siphon subequal to, or longer than abdomen 9
9. Antenna with lateral projection of penultimate segment not greater than one half the length of the last segment 10
Antennae with lateral projection of penultimate segment greater than one half the length of the last segment 11
10. Prosternum with a single wide, deep, longitudinal trough ..... *Ranatra buenoi* (p. 308)
Prosternum without single wide, deep, longitudinal trough, but having two longitudinal depressed lines ..... *Ranatra nigra* (p. 309)
11. Jugae of head more prominent than tylus ..... *Ranatra australis* (p. 309)
Jugae of head not prominent, equal to tylus ..... *Ranatra fusca edentula* (p. 310)
12. Femora of fore legs without groove for reception of tibia ..... *Benacus griseus* (p. 325)
Femora of fore legs with groove 13
13. Head not conically produced; first segment of beak shorter than second; total length more than 40 mm. 14
Head conically produced; first segment of beak longer than second (except in *Belostoma bakeri*); length less than 30 mm. 15
14. Interocular space equal to width of eye ..... *Lethocerus americanus* (p. 325)
Interocular space not over ¾ width of eye ..... *Lethocerus uhleri* (p. 325)
15. Hair not covering entire mesal area of connexivum; less than 25 mm. total length ..... *Belostoma testaceum* (p. 326)
Hair covering entire mesal area of connexivum 16
16. Band of hair on connexivum not touching genital operculum ..... *Belostoma lutarium* (p. 327)
Band of hair on connexivum touching genital operculum 17
17. First segment of beak shorter than second ..... *Belostoma bakeri* (p. 328)
First segment of beak longer than second ..... *Belostoma flumineum* (p. 326)
18. Base of head not inserted in thorax; fore tarsi palaeform, specialized for feeding ..... Corixidae
Base of head inserted in thorax; fore tarsi not palaeform 19
19. Total length less than 3.0 mm. (Pleidae). One genus, one species ..... *Plea striola* (p. 316)
Total length more than 4.0 mm. (Notonectidae) 20
20. Last segment of antenna shorter than penultimate segment 21
Last segment of antenna longer than penultimate segment ..... *Buenoa* spp. (p. 315)
21. With black band across distal end of white hemelytra; male clasper incised at tip 22
Without black band across distal end of hemelytra; or, if black band is present, hemelytra red or orange; male clasper not incised at tip 23
22. Light colored area of hemelytra posterior to black band not as wide as black band itself; male clasper shallowly incised ..... *Notonecta indica* (p. 313)
Light colored area of hemelytra posterior to black band wider than band itself; male clasper deeply incised from 1/3 to 1/2 length of the clasper ..... *Notonecta undulata* (p. 315)
23. Mesotrochanter plainly angulate; male genital capsule without digitate process ..... *Notonecta uhleri* (p. 314)
Mesotrochanter rounded; male genital capsule with digitate process ..... *Notonecta irrorata* (p. 314)
24. Head narrow, with protruding eyes, as long as entire thorax (Hydrometridae) 25
Head shorter than entire thorax 27

25. Pits on pro- and meso-acetabula usually two in number 26
Pits on pro-and meso-acetabula usually four in number ..... *Hydrometra australis* (p. 313)

26. Second antennal segment two and one-half times length of segment one ..... *Hydrometra myrae* (p. 311)
Second antennal segment not more than twice the length of segment one ..... *Hydrometra martini* (p. 311)

27. Claws of all legs located at apices of tarsi; tarsi three-segmented 28
Claws of fore tarsi not at apex 30

28. Membrane of hemelytra, when present, without veins (Mesoveliidae) 29
Membrane of hemelytra with veins ..... Saldidae (p. 321)

29. Fore- and mid-femora with a row of black spines on hind margin ..... *Mesovelia mulsanti bisignata* (p. 320)
Fore- and mid-femora without a row of black spines; head with two brown stripes ..... *Mesovelia amoena* (p. 320)

30. Hind femora long, extending beyond end of the abdomen; mid and hind legs very distant from fore legs (Gerridae) 31
Hind femora short, not extending much beyond end of abdomen; mid legs equidistant from both fore and hind legs (Veliidae) 42

31. Inner margin of eyes concave or sinuate behind the middle; body long 32
Inner margin of eyes convexly rounded; body short 38

32. Pronotum sericeous, dull, in wingless forms fused with mesonotum; basal segment of fore tarsus but little shorter than apical one 33
Pronotum glabrous, shining, in wingless forms not fused with mesonotum; basal segment of fore tarsus much shorter than apical one ..... *Limnogonus hesione* (p. 323)

33. Segment one of antenna distinctly longer than two and three united 34
Segment one of antenna not, or but slighly longer than two and three united 36

34. Pronotum without median keel; spines of sixth abdominal sternite not reaching apex of genital segment ..... *Gerris remigis* (p. 321)
Hind lobe of pronotum with a distinct median keel; spines of sixth abdominal sternite just surpassing apex of genital segment 35

35. Hind margin of sixth abdominal sternite of male shallowly concave ..... *Gerris conformis* (p. 321)
Hind margin of sixth abdominal sternite of male deeply and roundly concave ..... *Gerris nebularis* (p. 321)

36. Lateral margins of fore lobe of pronotum same in color as disk ..... *Gerris marginatus* (p. 322)
Lateral margins of fore legs of pronotum with a pale stripe 37

37. Antenna less than half the length of the body ..... *Gerris argenticolis* (p. 322)
Antenna half or more the length of the body ..... *Gerris canaliculatus* (p. 322)

38. First antennal segment nearly or almost equal to remaining three united ..... *Metrobates hesperius* (p. 323)
First antennal segment much shorter than remaining three united 39

39. Fourth antennal segment equal to, or shorter than third; abdomen as long as remainder of body ..... *Rheumatobates hungerfordi* (p. 323)
Fourth antennal segment distinctly longer than third; abdomen much shorter than remainder of body 40

40. Second genital segment without long hairs beneath; second and third antennal segments subequal ..... *Trepobates subnitidus* (p. 324)
Second genital segment thickly pilose beneath; second antennal segment shorter than third 41

41. Mesothoracic leg with femur and tibia clothed on inner margin with short, setose hairs, never longer than half the diameter of segments on which they arise ..... *Trepobates pictus* (p. 324)
Mesothoracic leg with femur and tibia clothed on inner margin with a fringe of hairs subequal in length to the diameter of the segment on which they arise ..... *Trepobates inermis* (p. 324)

42. Fore tarsi with three segments 43
Fore tarsi with two segments 44
43. Mid-tarsus subequal in length to hind tarsus; the mid-tarsus with segments two and three subequal in length; head not set in thorax .....*Velia watsoni* (p. 317)
Mid-tarsus longer than hind tarsus; mid-tarsus with segment two longer than three; head set in thorax to eyes .....*Velia brachialis* (p. 318)
44. Antenna longer than head and pronotum together .....*Microvelia americana* (p. 318)
Antenna subequal to or shorter than head and pronotum together 45
45. Hind tibia curved in male; in apterous form pronotum with transverse linear impression before the middle .....*Microvelia borealis* (p. 318)
Hind tibia not curved in male; pronotum without a linear impression in apterous forms 46
46. Apterous form with small white vestigial wings; pronotum produced backward to second abdominal tergite .....*Microvelia atrata* (p. 319)
Apterous form without vestigial wings; pronotum not produced backward .....*Microvelia hinei* (p. 319)

NEPIDAE

CURICTA DRAKEI Hungerford

Curicta drakei Hungerford, 1922, Univ. Kans. Sci. Bull. 14: 432.

Diagnosis.—Length ranges from 16 to 22 mm. exclusive of the respiratory filaments which are seven to eight mm. long. Eyes small, globular; tylus longer than jugae; penultimate segment of antenna with a long slender prolongation. Membrane of wing well developed and as long as elytral suture. Fore coxa and femur stout, the coxa one-half the length of the femur which bears a well-developed tooth nearer the base than the apex; metathoracic femur and tibia of equal length.

Distribution.—There are only four specimens in the Tulane collection. The Louisiana records are: JEFFERSON: one, Waggaman, IV-5-49, GHP (TU 1153); LAFOURCHE: two, Roux, XII-13-48, LLE, GHB (TU 893); ORLEANS: one, New Orleans (Audubon Park), IV-8-49, JFA (TU 1160); three, New Orleans (Hungerford, 1922).

Ecology.—Three of the specimens in the Tulane collection were taken in fresh-water marshes from one to four feet deep, and the fourth from a fresh-water lagoon. There was abundant submerged, floating and emergent vegetation in each case.

RANATRA BUENOI Hungerford

Ranatra buenoi Hungerford, 1922, Univ. Kans. Sci. Bull. 14: 442. *R. fusca* Torre-Bueno, 1905, Canad. Ent. 37: 183.

Diagnosis.—Length (exclusive of filament) ranges from 32 to 38 mm. Eyes very prominent; tylus longer than jugae; lateral prolongation of penultimate segment of antenna not more than half the length of last segment; anterior femur strikingly long, with no apical tooth; distal end of hind femur surpassing the last abdominal suture; tarsus small, less than $\frac{1}{8}$ as long as tibia.

Distribution.—Although records in southeastern Louisiana are rather scattered it is evident that this species occurs mostly in the lowlands.

The Louisiana records are: IBERVILLE: five, Grosse Tete, XII-16-48, GHP, GHB (TU 814); MADISON: Mound (Hungerford, 1922); ORLEANS: one, New Orleans, III-21-28 (TU P. 124); one, New Orleans, VI-21-33, M. Wright (TU P. 120); POINTE COUPEE: one, Valverda, XII-17-48, GHP, GHB (TU 824); ST. CHARLES: four, Norco, IV-20-48, LLE, GHB (TU 204); ST. MARTIN: one, Keystone, IV-3-49, GHB,

JFA (TU 485); ST. MARY: one, Berwick, II-10-41, GHP (TU P. 24); six, 1 mi. s. Centerville, IV-3-49, GHB, JFA (TU 491); ST. TAMMANY: one, Lacombe, XI-7-48, LLE (TU 853); one, Goodbee, VII-31-48, GHP (TU 712); one, Pearl River, III-26-39, ESH (TU P. 50); one, Indian Village, X-4-36, TFH (TU P. 110); WASHINGTON: one, Bogalusa, VIII-11-48, GHP (TU 751).

Ecology.—In a total of eight collections with data, *R. buenoi* was most commonly found in permanent bodies of fresh water (100%), which were flowing (88%), exposed (88%), clear (75%), mud-bottomed (75%), and in which aquatic vegetation was present (88%). Depth of the water ranged from 6" to 3'. The habitats recorded were creeks (50%), bayous (25%), swamps (12%) and ditches (12%). Aquatic plants in these habitats in the order of their frequency were: *Alternanthera philoxeroides, Jussiaea* sp., *Polygonum* sp., *Ceratophyllum* sp, *Lemna* sp., *Typha* sp., and *Scirpus* sp.

RANATRA NIGRA Herrick-Schäffer

Ranatra nigra Herrick-Schäffer, 1853, G. A. W. Wanzenartiger insectung 9: 32. *R. protensa* Montandon, 1910, Bull. Soc. Sci. Bucarest 18: 185.

Diagnosis.—Antenna with lateral prolongation of penultimate segment not greater than one-half of the length of the last segment; prosternum with two longitudinal depressed lines; prominent angular mesocoxa and metacoxa; prothorax constricted in front of the mesocoxa.

Distribution.—Only a few specimens have been collected in Louisiana; these records are: LAFOURCHE: seven, Des Allemands, IV-23-37, J. G. Needham, ESH, GHB, TFH (TU P. 85); ORLEANS: one, Micheaud, IX-29-48, GHB (TU 877); one, New Orleans, VI-9-48, GHB (TU 377); TANCIPAHOA: one, 3 mi. e. Amite, V-7-48, GHP, LLE (TU 220).

Ecology.—In the three collections with data this species was found entirely in permanent bodies of water, which were clear, mud-bottomed and with abundant aquatic vegetation. These habitats were two exposed ponds and one shaded bayou.

RANATRA AUSTRALIS Hungerford

Ranatra australis Hungerford, 1922, Univ. Kans. Sci. Bull. 14: 449.

Diagnosis.—Length ranges from 32 to 37 mm. exclusive of terminal filaments. Jugae very prominent and more elevated than the tylus; antenna with lateral extension of penultimate segment nearly as long as last segment; respiratory filament nearly as long as length of body; fore femur broad and without apical tooth; hind tarsus 1/6 length of tibia.

Distribution.—This species seems to be restricted to the Deltaic plain and Mississippi alluvial plain in the southeastern section of Louisiana.

The Louisiana records are: CAMERON: one, Creole, IV-22-40, GHP, P. Viosca (TU P. 553); IBERIA: one, Olivier, IV-3-49, GHB, JFA (TU 489); IBERVILLE: one, 4 mi. sw. Plaquemine, XII-16-48, GHP, GHB (TU 812); two, 7 mi. s. Grosse Tete, XII-16-48, GHP, GHB (TU 814); JEFFERSON: one, Waggaman, X-17-47, LLE, JVB (TU 116); one, 3 mi. n. Kenner, III-19-48, GHP, LLE (TU 157); LAFOURCHE: one, Roux, XII-13-48, GHB, LLE (TU 893); LIVINGSTON: Colvell (Hungerford, 1922); MADISON: Mound (Hungerford, 1922); ORLEANS: two, New Orleans, III-21-28 (TU P. 124); three, Micheaud, VI-21-33, M. Wright (TU P. 120); two, New Orleans, VI-9-48, GHB (TU 377); one, New Orleans, VI-16-48, GHB (TU 378); one, New Orleans, I-12-49, LLE (TU 907); New Orleans (Hungerford, 1922); PLAQUEMINES: one, 1 mi. s. Port Sulfur, XII-23-48, LLE (TU 835); ST. BERNARD: one, 3 mi. n. Chalmette, III-12-37, GHB (TU P. 80); ST. MARY: three, 1 mi. s. Cen-

terville, IV-3-49, GHB, JFA (TU 491), two, Morgan City, IV-3-49, GHB, JFA (TU 492); ST. TAMMANY: one, Fontainebleau State Park, VII-14-48, GHP (TU 767); WEST BATON ROUGE: one, 5 mi. sw. Alford, XII-17-48, GHP, GHB (TU 819).

Ecology.—In a total of fourteen collections with data, *R. australis* was most commonly found in permanent bodies of fresh water (100%), which were exposed (78%), clear (86%), with colorless water (57%), mud-bottomed (78%), static (64%) and with abundant vegetation (50%). The habitats recorded were marshes (14%), ponds (21%), bayous (21%), ditches (14%), borrow pits (14%), sloughs (8%) and lakes (8%). Aquatic plants in these habitats in order of frequency were *Alternanthera philoxeroides, Eichhornia crassipes, Lemna* sp., and *Ceratophyllum* sp.

RANATRA FUSCA EDENTULA Montandon

Ranatra americana var. *edentula* Montandon, 1910, Bull. Soc. Sci. Bucharest 19: 65. *Ranatra fusca* var. *edentula* Hungerford, 1922, Univ. Kans. Sci. Bull. 14: 446.

Diagnosis.—Legs short; fore femur stout, one-half longer than coxa; anterior portion of the prothorax about one and one-half times longer than the swollen posterior portion; hind tibia a little longer than the femur, reaching to the apical fourth of the siphon; apical tooth of the fore femur missing; length of body ranges from 35 to 42 mm.

Distribution.—Only one specimen (without ecological data) is in the Tulane collection: JEFFERSON: one, Bridgedale, V-3-37, ESH, TFH (TU P. 70).

GELASTOCORIDAE

GELASTOCORIS OCULATUS (Fabricius)

Naucoris oculatus Fabricius, 1798, Supplement. Ent. Syst. p. 525. *Galgulus oculatus* (Fabr.) Latreille, 1802, Hist. Nat. Crust. Ins. 3: 254. *Gelastocoris oculatus* (Fabr.) Kirkaldy, 1897, Entomologist 30: 258 (nov. nom. for *Galgulus* Latreille). *Gelastocoris barberi* Torre-Bueno, 1923, Conn. Nat. Hist. Surv. Bull. 34: 393. *Gelastocoris subsimilis* Blatchley, 1926, Heterop. East. North Amer. p. 1025.

Diagnosis.—General body color yellowish brown; eyes conspicuous, protruding outward; fore lobe of pronotum with five to six ridges of tubercles of which two or more extend onto the hind lobe; scutellum with a tubercle on each side of median ridge; hemelytra extends over end of abdomen exposing a narrow margin of the connexivum.

Distribution.—Occurs throughout southeastern Louisiana except perhaps the marshes subject to salt influence. The Louisiana records are: ASCENSION: five, Hope Villa, X-9-35, H. B. Chase (TU P. 757); JEFFERSON: nine, Waggaman, IV-6-48, GHP, LLE (TU 189); two, Kenner, XI-5-45, ESH (TU P. 8); one, Bridgedale, XI-1-28 (TU P. 448); ORLEANS: one, New Orleans (Audubon Park), II-18-37, GHP, GHB, R. T. Perkins (TU P. 193); two, New Orleans, XI-9-37, ESH (TU P. 401); ST. BERNARD: one, Yscloskey, XI-17-31, ESH (TU P. 838); ST. JOHN: one, Frenier, V-7-48 (TU 224); ST. TAMMANY: one, Pearl River, III-26-39, ESH, C. A. Pipkin (TU P. 46); nine, St. Tammany, V-12-49, GHP (TU 1217); TANGIPAHOA: one, Baptist, VII-12-48, GHP (TU 768); WASHINGTON: one, 1½ mi. s. Enon, VIII-10-48, GHP (TU 745).

Ecology.—*Gelastocoris oculatus* is a semi-aquatic species, restricted for the most part to damp situations found along the banks of sandy creeks, muddy ponds and swamps, which may be either shaded or exposed.

GELASTOCORIS VARIEGATUS (Guerin-Meneville)

Galgulus variegatus Guerin-Meneville, 1844, Econ. Ins. p. 352

Diagnosis.—Broadly oval; pronotum subparallel at the sides anteriorly; lateral angles boliaceous, very distinctly crenate anteriorly and posteriorly; general color above bronzed brown with a metallic tinge; abdomen black.

Distribution.—This species has not been recorded from Louisiana, but probably occurs since it ranges from Maryland to Florida and Texas in the United States.

HYDROMETRIDAE

HYDROMETRA MARTINI Kirkaldy

Hydrometra martini Kirkaldy, nov. nom., 1900, Entomologist 33: 175. *Hydrometra lineata* Say, 1859, Comp. Writings 1: 361 (preoccupied by *H. lineata* Eschsch, 1822).

Diagnosis.—Body color fuscous or brown, sometimes with a bluish tinge; hemelytra whitish with almost black nervures; in winged specimens hemelytra reaches sixth tergite in the male, fifth in the female; sixth abdominal segment in male with two raised crescent-shaped tubercles; with poorly defined median longitudinal whitish line on pronotum; two pits on either side of pleural suture above pro- and mesocoxae.

Distribution.—This species seems to be located primarily in those particular parishes surrounding Lake Pontchartrain.

The Louisiana records are: ORLEANS: 1 female, New Orleans (City Park), 3-9-49, JFA (TU 955); PLAQUEMINES: 1 female, 1 mi. s. Port Sulfur, 12-23-48, LLE (TU 835); ST. JOHN: 1 female, Frenier, 10-24-47, GHP, LLE (TU 121); 1 male, Reserve, 11-21-48, GHP, GHB, LLE (TU 855); ST. TAMMANY: 1 male, Hickory, 4-16-48, GHP, LLE (TU 198); 2 females, 2.5 mi. s. Lacombe, 3-19-49, GHB (TU 979); TANGIPAHOA: 1 female, 1 mi. n. Tangipahoa, 8-13-48, GHP (TU 777); WEST FELICIANA: 1 female, 9 mi. w. Jackson, 1-25-49, GHB, LLE (TU 915).

Ecology.—In a total of eight collections with data, *H. martini* was found most commonly in permanent bodies of fresh water (75%), which were exposed (77%), clear (100%), amber in color (75%), static (88%), mud-bottomed (100%), and in which aquatic vegetation was moderately to abundantly present (75%). Habitats recorded were man-made excavations such as ditches and borrow-pits (50%), ponds (25%) and swamps and sloughs (25%). Aquatic plants in these habitats in order of their frequency were *Alternanthera philoxeroides*, *Azolla* sp., *Pistia* sp., *Myriophyllum* sp., *Polygonum* sp., *Pontederia* sp., and *Saururus* sp.

HYDROMETRA MYRAE Torre Bueno

Hydrometra myrae Torre Bueno, 1926, Ent. Amer. 7: 110.

Diagnosis.—Antenna with second segment two and one-half times as long as first segment and subequal to the fourth; thorax with long pronotum containing minute scattered pits; wings, when present, reaching beyond middle of fourth abdominal segment in male, to about middle of abdomen in female; pits present on pleuron above pro- and mesocoxae, one on each side of suture; abdominal processes of male linear, curved, black, similar to those of *H. martini*; terminal segment widened with a long stout spine.

Distribution.—This species is rather well spread throughout the southeastern section of Louisiana.

The Louisiana records are: AVOYELLES: 1 male, 2 females, 2 mi. s. Marksville, VIII-7-48, LLE (TU 436); EAST FELICIANA: 2 males, 3 females, 2 mi. n. Lindsay, I-26-49, LLE, GHB (TU 911); IBERIA: 1 male, Spanish Lake at New Iberia, 4-3-49, GHB, FA (TU 483); Olivier, 4-3-49, 1 female GHB, JFA (TU 489); JEFFERSON: 1 female, Bridgedale, 2-19-39, ESH (TU P. 41); 1 female, Lake Pontchartrain at Bucktown, 7-6-48, GHB (TU 614); 3 females, Crown Point, 8-4-48, GHB (TU 727); 1 female, Lafitte, 8-4-48, GHP (TU 725); 3 males, Waggaman, 4-6-48, GHP, LLE (TU 187, 188); 2 males, 1 female, Waggaman, 4-5-49, GHP (TU 1153, 1177); LIVINGSTON: 1 female, Springfield, 7-12-48, GHP (TU 763); ORLEANS: 1 female, New Orleans (City Park), 3-9-49, JFA (TU 955); 3 males, 1 female, New Orleans (Audubon Park), 3-19-49, JFA (TU 963); 1 male, New Orleans (Audubon Park), 3-18-49, JFA (TU 1133); 2 males, 1 female, New Orleans (Audubon Park), 4-8-49, JFA (TU 1160); 1 male, 3 females, Little Woods, 5-3-49, GHP (TU 1206); 3 females, New Orleans, 6-16-49, GHP (TU 1266). PLAQUEMINES: 1 female, 1 male, De Feleice, 12-23-48, LLE (TU 834); 2 males, 3 females, 1 mi. s. Port Sulfur, 12-23-48, LLE (TU 835); POINTE COUPEE: 1 male, Lakeland, 12-17-48, GHP, GHB (TU 821); ST. CHARLES: 1 male, Sarpy Refuge, 4-20-48, GHP, LLE (TU 204); ST. HELENA: 2 females, 4 mi. w. Darlington, 7-3-48, GHP (TU 576); 1 female, 3 mi. e. Greensburg, 8-13-48, GHP (TU 773); 1 male, 1 mi. ne. Liverpool, 8-13-48, GHP (TU 775); ST. JOHN: 1 female, Reserve, 11-21-48, GHP, LLE (TU 855); ST. MARY: 1 female, 1 male, 3 mi. n. Franklin, 8-25-48, GHP (TU 105); ST. TAMMANY: 1 male, 4.7 mi. ne. Covington, GHP (TU 728); 1 female, Lacombe, 11-7-48, LLE (TU 853); 2 females, Pearl River, 12-1-48, F. R. Cagle, J. Siekman (TU 878); 1 male, 2 females, Hickory, 4-16-48, GHP, LLE (TU 198); 1 male, Hickory, 4-24-49, GHP (TU 1085); 1 female, Ramsay, 8-13-48, GHP (TU 781); 1 male, 1 female, St. Tammany, 3-26-49, GHB (TU 458); 1 male, 1 female, St. Tammany, 5-12-49, GHP (TU 1218); 1 male, 2 females, 1 mi. s. Sun, 8-11-48, GHP (TU 747); 1 male, 2 females, 2.5 mi. s. Lacombe, 3-19-49, GHB (TU 979). TANCIPAHOA: 1 male, 1 female, Arcola, 10-2-48, GHP, GHB, LLE (TU 451); 1 male, 1 female, Baptist, 8-12-48, GHP (TU 768); 1 male, 5 mi. e. Ponchatoula, 10-2-48, GHP, GHB, LLE (TU 113); 1 female, Ponchatoula Beach, 7-31-48 GHP (TU 719); 4 males, 7 females, 4 mi. e. Ponchatoula Beach, 8-12-48, GHP (TU 758); 1 female, Robert, 7-31-48, GHP (TU 717); 1 male, 1 mi. e. Roseland, 10-2-48, GHP, GHB, LLE (TU 447); 1 male, 2 females, 1 mi. n. Tangipahoa, 8-13-48, GHP (TU 777); 3 males, Tickfaw, 5-7-48, GHP, LLE (TU 219); TERREBONNE: 1 female, 1.5 mi. s. Dulac, 11-26-48, GHP, LLE (TU 873); WASHINGTON: 1 female, 6 mi. nw. Enon, 8-10-48, GHP (TU 746); 1 female, 1 mi. s. Rio, 8-11-48, GHP (TU 749); 2 males, 3.5 mi. s. Bogalusa, 8-11-48, GHP (TU 751); 1 male, 3 mi. sw. Franklinton, 8-13-48, GHP (TU 779); WEST BATON ROUGE: 2 females, Lake Clause, 12-17-48, GHP, GHB (TU 820); WEST FELICIANA: 1 female, 9 mi. w. Jackson, 1-26-49, GHB, LLE (TU 915).

Ecology.—In a total of 51 collections with data, *H. myrae* was found most commonly in permanent bodies of fresh water (90%), which were exposed (77%), clear (83%), amber in color (78%), static (78%), mud-bottomed (82%), and in which aquatic vegetation was moderately to abundantly present (70%). Three collections were taken in brackish water. Habitats recorded were man-made excavations such as ditches and borrow-pits (34%), natural ponds and lakes (24%), flowing creeks, bayous and rivers (22%), swamps and sloughs (12%), marshes (6%) and a puddle (2%). Aquatic plants in these habitats in order of their frequency were miscellaneous green algae, *Alternanthera philoxeroides*, *Eichhornia crassipes*, *Lemna* spp., *Azolla* sp., *Najas* spp., *Pontederia* sp., *Pistia* sp., *Jussiaea* sp., *Myriophyllum* sp., *Eleocharis* sp., *Polygonum* sp., *Nelumbo* sp., *Saururus* sp., *Typha* sp. and *Zizaniopsis* sp.

Several specimens were taken at night at a light in New Orleans in June (TU 1266).

HYDROMETRA AUSTRALIS Say

Hydrometra lineata var. *australis* Say, 1859, Comp. Writings 1: 361. *Hydrometra australis* Say, Torre Bueno, 1905, Canad. Ent. 37: 12-14.

Diagnosis.—Head slightly longer beyond the eyes and slightly dilated at tip; second antennal segment a little dilated at tip; lateral margin of male terminal segment straight; sixth abdominal segment of male with two conical elevations; four pits above pro- and mesocoxae, two on either side of suture; tip of abdomen in the female not as elongate as in *H. martini*.

Distribution.—This species is apparently well scattered throughout the southeastern section of Louisiana. The Louisiana records are: ASCENSION: three, 1 mi. w. Dutchtown, XII-17-48, GHP, GHB (TU 830); LAFOURCHE: one, Roux, XII-13-48, GHP, LLE (TU 893); ORLEANS: New Orleans (Type locality) (Say, 1859); ST. BERNARD: one, Chalmette, XI-7-47, GHP; LLE (TU 125); ST. TAMMANY: four, 4 mi. w. Covington, VII-31-48, GHP (TU 710); five, 4.7 mi. ne. Covington, VIII-9-48, GHP (TU 729); TANGIPAHOA: one, 3 mi. e. Amite, V-7-48, GHP, LLE (TU 220); four, 1 mi. e. Amite, VI-8-48, LLE (TU 411); one, Tickfaw, V-7-48, GHP, LLE (TU 219); WASHINGTON: two, 3½ mi. s. Bogalusa, VIII-11-48, GHP (TU 751); WEST BATON ROUGE: one, 3 mi. ne. Rosedale, XII-17-48, GHP, GHB (TU 826).

Ecology.—In a total of ten collections, *H. australis* was found most commonly in permanent bodies of fresh-water (76%) which were exposed (55%), clear (88%), static (76%), amber in color (55%), mud-bottomed (55%), with debris (55%) and without vegetation (55%). The habitats recorded were creek pot holes (44%), ponds (22%), swamps (11%), marshes (11%) and sloughs (11%). One collection was made on dry land (TU 411). Aquatic plants in some of these habitats in order of frequency were *Alternanthera philoxeroides*, *Lemna* sp., *Typha* sp. and *Wolffia* sp.

NOTONECTIDAE

NOTONECTA INDICA Linnaeus

Notonecta indica Linnaeus, 1771, Mantissa Plantarus 2: 534 (complete synonymy see Hungerford, 1933, p. 113).

Diagnosis.—Head greater than one-half the length of pronotum; vertex slightly longer, or as long as its anterior width when viewed from above; pronotum less than twice the length of the head; anterior trochanter of male with a stout hook; mesotrochanter rounded; female with a shallow notch at tip of terminal abdominal sternite; typical color black and white.

Distribution.—In addition to records listed by Hungerford there are only three additional in the Tulane collection. The Louisiana records are: EAST BATON ROUGE: Baton Rouge, III-9-29 (Hungerford, 1933); JEFFERSON: three, Southport, I-28-37, GHB, ESH (TU P. 73); MADISON: Mound, III-9-28 (Hungerford, 1933); ORLEANS: New Orleans, July, 1916 (Hungerford, 1933); ST. LANDRY: Opelousas, III-9-29 (Hungerford, 1933); ST. TAMMANY: one, 3 mi. w. Bush, VIII-9-48, GHP (TU 733); WASHINGTON: one, 6 mi. nw. Enon, VIII-10-48, GHP (TU 746).

Ecology.—There were only two collections with this data. Both were taken in permanent bodies of fresh-water which were static and mud-bottomed. One, a slough, was clear, amber in color, shaded and without vegetation; the other, a ditch, was turbid, colorless, exposed and with sparse vegetation.

NOTONECTA IRRORATA Uhler

Notonecta irrorata Uhler, 1879, Proc. Bost. Soc. Nat. Hist. 19: 443 (complete synonymy in Hungerford, 1933, p. 92).

Diagnosis.—Length ranges from 12.9 to 15.5 mm.; pronotum more than twice the length of the head; scutellum slightly wider than long; anterior outline of head flattened as viewed from above; inner margin of eyes divergent; mesotrochanter approximating a right angle; color irrorated, or with mottled brown appearance; pronotum, mesonotum and scutellum usually darker in color.

Distribution.—In southeastern Louisiana this species seems to be restricted to the higher sections of the Florida parishes bordering the transitional zone between the Pleistocene ridegs and the lowlands. Other scattered records in the state are in the Tertiary uplands.

The Louisiana records are: BOSSIER: twenty-three, Plain Dealing, VII-27-48, LLE (TU 424); two, 2 mi. s. Plain Dealing, VII-26-48, LLE (TU 423); CALDWELL: fifteen, 2½ mi. s. Columbia, VIII-4-48 ,LLE (TU 431); EAST BATON ROUGE: Baton Rouge, III-9-29 (Hungerford, 1933); ORLEANS: New Orleans (Hungerford, 1933); ST. TAMMANY: one, 4 mi. w. Covington, VII-31-48, GHP (TU 710); one, 2 mi. w. Goodbee, VII-31-48, GHP (TU 716); three, Lacombe, XI-7-48, LLE (TU 852); one, Pearl River, III-13-49, F. R. Cagle (TU 976); one, Pearl River, IV-15-39, E. C. Martin (TU P. 61); TANGIPAHOA: one, Ponchatoula Beach. X-2-48, GHP, GHB, LLE (TU 110); one, 1 mi. e. Tangipahoa, X-2-48, GHP, GHB, LLE (TU 450); WASHINGTON: four, 4 mi. s. Franklinton, VI-9-48, LLE (TU 409); two, 1 mi. s. Rio, VIII-11-48, GHP (TU 749); five, Varnado, VIII-11-48, GHP (TU 754).

Ecology.—In a total of twelve collections with data, *N. irrorata* was most commonly found in permanent bodies of fresh-water (83%), which were shaded (83%), clear (83%), amber in color (58%), static (66%), without aquatic vegetation (83%) and in which the bottom type varied considerably, sand and mud combinations about equally common. The habitats recorded were streams (23%), potholes beside streams (23%), ponds (23%), sloughs (15%), ditches (7%) and springs (7%).

NOTONECTA UHLERI Kirkaldy

Notonecta uhleri Kirkaldy, 1897, Ann. Mag. Nat. Hist. 20, ser. b: 58 (complete synonymy in Hungerford, 1933, p. 103).

Diagnosis.—Length 10 to 12 mm.; anterior margin of head slightly convex as seen from above; vertex longer than its anterior width; head shorter than pronotum; lateral margin of pronotum strongly divergent; scutellum longer or subequal to the pronotum; mesotrochanter right-angulate or slightly produced into a tooth or stout spine-like process; color orange to brick-red and black; scutellum black; hemelytra brick-red or orange with dark band extending from tip of clavus to the costal margin; pronotum lighter in color, almost reaching a yellow shade.

Distribution.—Few specimens have been recorded from the state. The Louisiana records are: IBERVILLE: one, 7 mi. s. Grosse Tete, XII-16-48, GHP, GHB (TU 814); LAFOURCHE: one, 1 mi. ne. Roux, XI-26-48, GHP, LLE (TU 865); ORLEANS: one, New Orleans, III-18-49, JFA (TU 993); New Orleans, 1837 (Museum of Paris) (Hungerford, 1933); New Orleans, (Torre Bueno, 1905).

Ecology.—The few specimens of *N. uhleri* from southeastern Louisiana

were found in permanent bodies of fresh water which were exposed, static, amber in color, mud-bottomed and with growths of aquatic vegetation. The three habitats recorded were creeks, lagoons and canals. Aquatic plants in these habitats were *Alternanthera philoxeroides*, *Eichhornia crassipes*, *Ceratophyllum* sp. and *Lemna* sp.

NOTONECTA UNDULATA Say

Notonecta undulata Say, 1832, Heterop. New Harmony, p. 39 (complete synonymy in Hungerford, 1933, p. 117).

Diagnosis.—Length ranges from 10.5 to 12.6 mm.; anterior outline of head rounded; pronotum twice as long as head, lateral margin straight; anterior trochanter of male with medium-sized hook; mesotrochanter not angulate; male genital clasper notched; terminal abdominal sternite of female notched at tip; color typically black and white.

Distribution.—There are no specimens from Louisiana in the Tulane collection; however there is a single record of this species: CAMERON: Cameron (Hine, 1906).

BUENOA SCIMITRA Bare

Buenoa scimitra Bare, 1925, Ent. News 36: 226.

Diagnosis.—Diagnoses for the three species of *Buenoa* are not included here, nor are the three species included in the key since the genus is currently being revised by a student working with Dr. Hungerford at the University of Kansas.

Distribution.—This species is heretofore unrecorded from Louisiana. Blatchley (1926) recorded it only from Kansas and North Carolina. In the Tulane collection there are two collections of thirteen specimens from Louisiana as follows: JEFFERSON: eleven, Southport, I-28-37, GHB, ESH (TU P. 73); ST. TAMMANY: two, Hickory, IV-24-49, F. R. Cagle (TU 1085).

Ecology.—Both collections were made in semi-permanent ponds with shallow water (less than 12 inches), which was amber, clear, shaded, mud-bottomed and with a moderate amount of submerged and emergent vegetation. The one at Southport was on the Mississippi river batture, the other in cut-over pinelands.

BUENOA ELEGANS (Fieber)

Anisops elegans Fieber, 1851, Rhynchotographien p. 61.

Distribution.—This species is heretofore unrecorded from Louisiana. Records in the Tulane collections are: LAFOURCHE: four, Roux, XII-13-48, GHB, LLE (TU 893); ST. CHARLES: two, Grammercy, VI-15-49, A. H. Chaney (TU 1263); ST. TAMMANY: twelve, Hickory, X-16-49, GHP (TU 1583); TERREBONNE: one, 3 mi. n. Houma, XI-26-48, GHP, LLE (TU 867); three, 3 mi. s. Houma, XI-26-48, GHP, LLE (TU 869).

Ecology.—In a total of five collections, *B. elegans* was found in permanent bodies of fresh water (80%), which were exposed (100%), static (100%), clear (100%), amber in color (75%), mud-bottomed (100%) and in which aquatic vegetation was abundant (80%). Habitats recorded were marshes and marsh ponds (40%), pineland ditch (20%), roadside lowland ditch (20%), and a lowland puddle (20%). Aquatic plants in these habitats were *Alternanthera philoxeroides*, *Eichhornia crassipes* and *Eleocharis* sp. (?).

? BUENOA LIMNOCASTORIS Hungerford

Buenoa limnocastoris Hungerford, 1923, Ent. News 34: 150.

Distribution.—Hitherto unrecorded from Louisiana. A single female has been collected: ST. CHARLES: near Norco, XII-6-48, GHB (TU 890).

Ecology.—The single specimen was found in a deep, shaded, permanent borrow pit in a swamp in which the water was brown-colored, static, mud-bottomed and with moderate aquatic vegetation present.

PLEIDAE

PLEA STRIOLA Fieber

Plea striola Fieber, 1844, Ent. Mono., Abh. hohm, Ges. Wiss, Prag. (5) III: 18-80, 227-416. *Plea harnedi* Drake, 1922, Ohio J. Sci. 22: 114. *Plea striola* Fieber, Ellis, 1950, Proc. Ent. Soc. Wash. 52: 104.

Diagnosis.—Body deeper than wide, short and oval; head, pronotum and hemelytra evenly punctate; scutellum not as densely or evenly punctate; hemelytra short, strongly decurved behind; eye color red to brown; fuscous markings prominent to absent; head with reddish-brown streak or large triangular dark spots between the eyes.

Distribution.—Records are rather sparse due to the small size of these insects; they are easily overlooked in routine collecting. Apparently widely scattered throughout the southeastern part of Louisiana.

The Louisiana records are: EAST BATON ROUGE: twenty-nine, University, XII-17-48, GHP, GHB (TU 827); JEFFERSON: thirty-seven, Avondale, VI-14-48, GHB (TU 381); ORLEANS: forty-four, Micheaud, XI-29-48, GHB (TU 877); nine, New Orleans (Audubon Park), XI-14-47, GHP, LLE (TU 130); ST. CHARLES: twelve, 3 mi. e. Norco, IV-20-48, GHP, LLE (TU 204); one hundred and sixty-eight, 3 mi. e. Norco, V-7-48, GHP, LLE (TU 226); ST. HELENA: three, 4 mi. w. Darlington, VII-3-48, GHP (TU 576).

Ecology.—In a total of seven collections, *Plea striola* was found most commonly in permanent bodies of fresh water (100%), which were exposed (86%), static (100%), clear (100%), amber in color (57%), mud-bottomed (100%), and in which aquatic vegetation was abundant (100%). The habitats recorded were ponds (86%), and bayous (14%). Aquatic plants recorded from these habitats in order of frequency were *Lemna* sp., *Alternanthera philoxeroides*, *Najas* sp., *Potamogeton* sp., *Jussiaea* sp. and *Zizaniopsis miliacea*.

NAUCORIDAE

PELOCORIS FEMORATUS (Palisot de Beauvois)

Naucoris femoratus Palisot de Beauvois, 1805, Ins. Recueillis en Afrique et en Amerique, p. 237. *Naucoris poeyi* Guerin-Meneville, 1844, Icon. Regne. Anim. Ins. p. 352. *Pelocoris femoratus* (Palisot de Beauvois). La Rivers, 1948, Ann. Ent. Soc. Amer. 41: 372.

Diagnosis.—Head with an obscure median impression; sides near eyes punctate; median length of pronotum less than twice width; middle of the anterior part with a triangular area with short impressed lines; scutellum and elytra punctate.

Distribution.—In southeastern Louisiana this species is apparently restricted to an area extending along the Mississippi river, forty miles wide on either side. The Louisiana records are: AVOYELLES: one, 2 mi. s. Marksville, VIII-7-48, LLE (TU 436); EAST

BATON ROUGE: six, University, XII-17-48, GHP, GHB (TU 827); IBERVILLE: four, Bayou Goula, XII-16-48, GHP, GHB (TU 808); two, 1 mi. n. Indian Village, XII-16-48, GHP, GHB (TU 813); JEFFERSON: one, Avandale, X-10-47, GHP, LLE, JVB (TU 104); one, Kenner, XI-5-45, ESH (TU P. 8); one, Waggaman, IV-6-48, GHP, LLE (TU 185); LAFOURCHE: two, DesAllemands, IV-23-37, J. G. Needham, ESH, GHB, TFH (TU P. 85); one, 1 mi. ne. Roux, XI-26-48, GHB, LLE (TU 865); nine, Roux, XII-13-48, GHB, LLE (TU 893); MOREHOUSE: one, Galion, VI-24-47, GHP (TU 69); ORLEANS: seven, New Orleans (Audubon Park), VI-9-48, GHB (TU 377); one, New Orleans (Audubon Park), V-6-37, GHB (TU P. 93); two, New Orleans (City Park), X-13-48, J. Krogsgard (TU 923); one, New Orleans (Audubon Park), IV-3-48, F. Deiler (TU 190); five, New Orleans (City Park), X-18-48, F. Deiler, LLE (TU 679); one, New Orleans (City Park), X-11-48 LLE (TU 453); ten, New Orleans (City Park), VI-16-48), GHB (TU 378); four, Micheaud, XI-20-36, ESH, TFH (TU P. 116); three, Micheaud, XI-29-48, GHB (TU 877); PLAQUEMINES: one, Fort Jackson, IV-11-37, GHB, ESH (TU P. 83); POINTE COUPEE: one, Valverda, XII-17-48, GHP, GHB (TU 824); ST. BERNARD: three, Chalmette, XI-7-47, GHP, LLE, JVB (TU 125); ST. CHARLES: thirty-six, Norco, XII-6-48, GHB (TU 890); one, St. Rose, II-15-48, GHP, GHB (TU 150); one 1½ mi. w. Ama. IV-1-49, GHP, E. N. Lambremont (TU 1001); ST. JAMES: one, Hester, XI-21-48, GHP, GHB, LLE (TU 860); ST. JOHN: two, Reserve, XI-21-48, GHP, GHB, LLE (TU 855); ST. MARTIN: two, St. Martinville, IV-3-49, GHB, JFA (TU 487); ST. MARY: ten, Morgan City, IV-3-49, GHB, JFA (TU 492); ST. TAMMANY: one, Indian Village, IX-20-36, TFH (TU P. 108); three Lacombe, XI-7-48, LLE (TU 853); one, 4 mi. w. Florenville, III-26-49, GHB (TU 459); Slidell, IX-14-30, (La Rivers, 1948); WEST BATON ROUGE: thirty-eight, Alford, XII-17-48, GHP, GHB (TU 819); two, Lake Clause, XII-17-48, GHP, GHB (TU 820).

Ecology.—In a total of 29 collections with data, *P. femoratus* was found most commonly in permanent bodies of fresh water (100%), which were exposed (69%), static (82%), clear (69%), with colorless water (52%), mud-bottomed (100%), and in which there was more or less abundant aquatic vegetation (95%). Habitats recorded were ponds (38%), ditches (24%), bayous (14%), creeks (10%), swamps (7%) and marshes (7%). Aquatic plants in these habitats in order of frequency were *Alternanthera philoxeroides, Lemna* sp., *Eichhornia crassipes, Jussiaea* sp., *Polygonum* sp., *Zizaniopsis milacea, Azolla* sp., *Wolffia* sp. and *Ceratophyllum* sp.

PELOCORIS CAROLINENSIS Torre-Bueno

Pelocoris carolinensis Torre-Bueno, 1907, Canad. Ent. 39: 227.

Diagnosis.—Length 8.2 to 9.6 mm.; prothorax stout, margins flattened; connexivum exposed with hind angles of its segments prolonged; female genital segment densely punctate and deeply notched; male genital segment abruptly truncate.

Distribution.—No records from Louisiana, but it may occur since Blatchley (1926) and La Rivers (1948) have recorded it from North Carolina, Florida and Kansas.

VELIIDAE

VELIA WATSONI Drake

Velia watsoni Drake, 1919, Fla. Buggist 3: 1.

Diagnosis.—An elongate slender species with subparallel sides; disk of pronotum with median longitudinal keel; a distinct tubercle on each side anterior to the middle.

Distribution.—Only one collection from Louisiana; this record is: ST. JOHN: one, Reserve, XI-21-48, GHP, GHB, LLE (TU 855).

Ecology.—The single specimen was taken in a permanent borrow pit in fresh water that was clear and amber in color; vegetation and debris were present in moderate quantity including *Azolla* sp., *Polygonum* sp. and *Alternanthera philoxeroides*.

VELIA BRACHIALIS Stål

Velia brachialis Stal, 1860, Svenska Vet.-Akad. Handl. 11(7): 82. *Velia australis* Torre-Bueno, 1916, Bull. Brooklyn Ent. Soc. 11: 54.

Diagnosis.—Oblong, much more robust than *watsoni;* head with a median line; segment one of antenna nearly twice as long as segment two; segments two and four subequal; segment three slightly longer than either two or four; humeral angle of pronotum rounded and prominent, hind margin obtusely rounded; hemelytra narrow and barely shorter than the abdomen; other characters as in the key.

Distribution.—Records are rather sparse and well scattered, but apparently this species occurs throughout the southeastern section of the state. The Louisiana records are: AVOYELLES: one, 2 mi. s. Marksville, VIII-7-48, LLE (TU 436); IBERVILLE: one, 1 mi. n. Indian Village, XII-16-48, GHP, GHB (TU 813); JEFFERSON: two, Waggaman, IV-5-49, GHP (TU 1177); ORLEANS: one, New Orleans (Audubon Park), VI-9-48, GHB (TU 377); one, New Orleans (City Park), X-11-48, LLE (TU 453); TANGIPAHOA: one, Arcola, X-2-48, GHP, GHB, LLE (TU 451).

Ecology.—In six collections, *V. brachialis* was found most commonly in permanent bodies of fresh water (100%) which were exposed (83%), clear (50%), colorless (66%), mud-bottomed (100%), static (100%) and with abundant aquatic vegetation (100%). The habitats recorded were ponds (66%) and bayous (33%). Aquatic plants in these habitats were *Eichhornia crassipes* and *Lemna* sp.

MICROVELIA AMERICANA (Uhler)

Hebrus americana Uhler, 1884, Stand. Nat. Hist. 2: 274.

Diagnosis.—Alate form largely black with yellow or grayish pubescence on head and pronotum; segment two of antenna shortest, four slightly exposed; apterous forms dark brown and yellow; the connexivum mostly yellow, edged in dark brown or black; body surface thickly covered with short silvery-gray hairs; pronotum with transverse linear impressions before the middle.

Distribution.—There is only one specimen in the Tulane collection. This is: WEST FELICIANA: one, 2 mi. nw. Bains Post Office, I-26-49, GHB, LLE (TU 913).

Ecology.—This one specimen was taken in a shaded, flowing creek with a sand and gravel bottom. The water was clear and free of vegetation although there was a moderate amount of debris present.

MICROVELIA BOREALIS Torre-Bueno

Microvelia borealis Torre-Bueno, 1916, Bull. Brooklyn Ent. Soc. 11: 59.

Diagnosis.—Alate form: male slender, elongate; female broad, oval in shape; head and pronotum chestnut to dark brown, the head with a silvery streak next to eyes; cells of hemelytra grayish, the apical cell whitish; segments

one and three of antenna about equal in length, two shortest. Apterous form: usually darker, the ventral surface largely black; connexivals with small yellow spots; mesonotum not concealed; pronotum with a transverse linear line; hind tibia of male distinctly bent in both apterous and alate forms.

Distribution.—Only three collections from Louisiana; these are: ORLEANS: two, New Orleans (Audubon Park), XI-14-47, GHP, LLE, JVB (TU 130); WEST BATON ROUGE: four, Alford, XII-17-48, GHP, GHB (TU 819); WEST FELICIANA: one, 9 mi. w. Jackson, I-26-49, GHB, LLE (TU 915)).

Ecology.—All three collections were made in permanent bodies of clear, colorless water which were exposed and mud-bottomed; vegetation was abundant to moderate in all. Habitats recorded were two ponds and one flowing creek. Aquatic plants present were *Lemna* sp., *Potamogeton* sp., and *Zizaniopsis miliacea*.

MICROVELIA ATRATA Torre-Bueno

Microvelia atrata Torre-Bueno, 1916, Bull. Brooklyn Ent. Soc. 11: 60.

Diagnosis.—Male elongate, oblong, more oval shaped than female; color varies from a very dark red to brown with yellow markings; first segment of antenna shortest and almost as long as the fourth which is longest; apterous forms with pronotum triangular, extending back to the base of the second abdominal tergite, with white wing pads protruding from beneath angle; alate forms black with clavus and corium white at base.

Distribution.—Only four collections from Louisiana; these are: ORLEANS: one, New Orleans (Audubon Park), XI-14-47, GHP, LLE, JVB (TU 129); ST. TAMMANY: four, 4 mi. w. Covington, VII-31-48, GHP (TU 710); nine, Lacombe, XI-7-48, GHB, LLE (TU 853); WASHINGTON: one, 1½ mi. n. Varnado, VIII-11-48, GHP (TU 754).

Ecology.—In a total of four collections *M. atrata* was found most commonly in permanent bodies of fresh water (100%), which were exposed (50%), flowing (75%), clear (100%), amber in color (75%), mud-bottomed (75%) and with aquatic vegetation present (50%). Habitats recorded were creeks (50%), sloughs (25%) and ponds (25%).

MICROVELIA HINEI Drake

Microvelia hinei Drake, 1920, Ohio J. Sci. 20: 207.

Diagnosis.—Apterous form: male elongate oval, female slightly broader; antennal segment two shortest, four longest and one about equal to three; pronotum wider than long (about four times) with a transverse row of punctures near the front margin; mesonotum more than half as long as pronotum.

Distribution.—Only two collections from Louisiana; these are: ORLEANS: one, New Orleans, II-14-49, LLE (TU 938); ST. MARY: six, 3 mi. n. Franklin, VIII-25-48, GHP (TU 105).

Ecology.—One of these collections (New Orleans) was made in an artificial container (turtle tanks at Tulane campus); the other in static, turbid fresh water of a milky color in a mud-bottomed, temporary ditch. There was little vegetation present.

MESOVELIIDAE

MESOVELIA MULSANTI BISIGNATA Uhler

Mesovelia mulsanti White, 1879, Trans. Ent. Soc. London 1879: 268. *Mesovelia bisignata* Uhler, 1884, Stand. Nat. Hist. 2: 274. *Mesovelia mulsanti bisignata* Uhler, Jaczewski, 1930, Ann. Mus. Zool. Polonici 9: 5.

Diagnosis.—Antennal segments one and three subequal in length, segment two shortest; fore- and mid-femora with setae; color greenish with yellow hue; hind lobe of pronotum with a median yellow stripe.

Distribution.—Generally found abundantly throughout the southeastern section of Louisiana extending into the higher lands as well as the lowlands, and possibly also into the brackish marshes of the coastal regions.

The Louisiana records are: ASCENSION: one, Donaldsonville, XII-16-48 GHP, GHB (TU 805); AVOYELLES: six, 2 mi. s. Marksville, VIII-7-48, LLE (TU 436); JEFFERSON: one, Barataria, VIII-4-48, GHP (TU 724); two, Crown Point, VIII-4-48, GHP (TU 727); two, Waggaman, X-17-47, LLE JVB (TU 116); ORLEANS: three, Micheaud, XI-28-48, GHB (TU 877); two New Orleans (Audubon Park), XI-14-47, GHP, LLE, JVB (TU 130); one, New Orleans (City Park), V-11-48, LLE (TU 453); PLAQUEMINES: five, 2½ mi. n. DeFeleice, XII-23-48, LLE (TU 833); one, DeFeleice, XII-23-48, LLE (TU 834); one, 1 mi. s. Port Sulfur, XII-23-48, LLE (TU 835); POINTE COUPEE: four, Lakeland, XII-17-48, GHP, GHB (TU 821); ST. BERNARD: two, Chalmette, XI-7-47, GHP, LLE, JVB (TU 125); ST. CHARLES: three, Norco, IV-20-48, GHP, LLE (TU 204); three, Norco, XII-6-48, GHB (TU 890); four, 3 mi. e. Norco, V-7-48, GHP, LLE (TU 226); ST. JOHN: two, Reserve, XI-21-48, GHP, GHB, LLE (TU 855); ST. LANDRY: Opelousas (Jaczewski, 1930); ST. TAMMANY: four, 2½ mi. s. Lacombe, III-19-49, GHB, JFA (TU 979); two, Slidell, III-19-49, GHB, JFA (TU 980); eight, 3 mi. se. Slidell, III-19-49, GHB, JFA (TU 981); TANGIPAHOA: one, 5 mi. e. Ponchatoula, X-2-48, GHP, GHB, LLE (TU 113); one, 1 mi. e. Amite, X-2-48, GHP, GHB, LLE (TU 445); three, Arcola, X-2-48, GHB, GHP, LLE (TU 451); TERREBONNE: ten, 3 mi. n. Houma, XI-26-48, GHP, LLE (TU 867); eight, 1 mi. s. Dulac, XI-26-48, GHP, LLE (TU 874); WEST BATON ROUGE: seven, Alford, XII-17-48, GHP, GHB (TU 819).

Ecology.—In a total of 25 collections, *M. multisanti bisignata* was found most commonly in permanent bodies of fresh water (95%) which were exposed (77%), static (91%), clear (86%), amber or brown in color (73%), mud-bottomed (100%) and with aquatic vegetation present (100%). Habitats recorded were ponds (48%), bayous (28%), ditches (14%), sloughs (8%) and swamps (4%). Aquatic plants in these habitats in order of their frequency were *Lemna* sp., *Alternanthera philoxeroides*, *Azolla caroliniana*, *Eichhornia crassipes*, *Jussiaea* sp., *Pontederia* sp., *Wolffia* sp., *Pistia stratiodes*, *Potamogeton* sp., *Myriophyllum* sp., *Polygonum* sp., *Saururus cernus*, and *Zizaniopsis miliacea*.

MESOVELIA AMOENA Uhler

Mesovelia amoena Uhler, 1894, Proc. Zool. Soc. London, p. 218.

Diagnosis.—Color generally brown blotched with dusky yellow on pronotum, abdomen and connexivum; segment one of antenna stouter and longer than two by about 1/3; three and four subequal, each about 1/2 longer than one and two united; head with a definite medial line between two brown stripes; pronotum with hind margin concave, basal two-thirds convex.

Distribution and Ecology.—Only one Louisiana record: JEFFERSON: one, Crown

Point, VIII-4-48, GHP (TU 727). This was in a mud-bottomed bayou, exposed, amber in color, clear and with moderate amount of *Eichhornia crassipes* growing.

SALDIDAE

We have no specimens in the Tulane collections belonging to this family and since it is currently being revised by a student at the University of Kansas under Dr. Hungerford it seems wise merely to list the three species recorded from Louisiana without further comment. Hine (1906) recorded the following species all from Cameron, Cameron Parish, Louisiana: *Pentacora signoreti* (Guerin), *Pentacora sphacelata* (Uhler), *Saldula interstitialis* (Say).

GERRIDAE

GERRIS REMIGIS Say

Gerris remigis Say, 1832, Descrip. New Sp. Heteropt. Hemipt. North Amer. p. 35.

Diagnosis.—Antenna with segment one subequal to two and three united; fore lobe of pronotum concave at base; hind lobe three times as long, its posterior margins evenly rounded; sixth ventral segment of male with a rounded median concavity on hind margin; its spines not reaching to tip of first genital; general body color dark brown with reddish brown markings above and below.

Distribution.—No specimens in Tulane collection; recorded from Louisiana by Torre-Bueno (1911) and from Lafayette, Lafayette parish, La. by Liner (1949).

GERRIS CONFORMIS Uhler

Gerris conformis Uhler, 1878, Proc. Bost. Soc. Nat. Hist. 19: 435.

Diagnosis.—Antenna with segment one shorter than two and four united; pronotum wide with hind margin narrowly rounded; disk of hind lobe with definite low median keel; hemelytra entire, extending to the middle of sixth abdominal tergite; legs long, slender; sixth abdominal sternite of male with shallow concavity.

Distribution.—Recorded from Louisiana by Torre-Bueno (1911) without more specific data. Only one collection in the Tulane collection; this is: ST. LANDRY: two, 2 mi. w. Opelousas, IV-2-49, GHB, JFA (TU 476). These specimens were taken in a mud-bottomed premanent ditch in which the water was turbid, amber colored, flowing, exposed to sunlight and with sparse aquatic vegetation.

GERRIS NEBULARIS Drake and Hottes

Gerris nebularis Drake & Hottes, 1925, Proc. Biol. Soc. Wash. 38: 70.

Diagnosis.—Antenna with segment one almost as long as two and four united; pronotum wide, disk of second lobe with poorly developed median keel; hemelytra in long-winged form extending to base of first genital segment; in short winged form to middle of second or third abdominal segment; posterior margin of sixth abdominal sternite of male deeply concave.

Distribution.—Only three collections from Louisiana. These records are: CALDWELL: one, Columbia, VIII-2-48, LLE (TU 430); ST. LANDRY: one, Washington, VI-23-48, LLE (TU 417); WASHINGTON: one, Varnado, VI-3-48, LLE (TU 402).

Ecology.—In three collections this species was most common in bodies of

fresh water which were permanent, turbid, flowing, mud-bottomed, shaded and without vegetation. The habitats recorded were one each of pot-holes, bayous and creeks.

GERRIS MARGINATUS Say

Gerris marginatus Say, 1832, Descrip. New Sp. Heteropt. Hemipt. North Amer. p. 36.

Diagnosis.—Antenna short and stout with segment one longer than four, two and three shorter; disk of posterior lobe of pronotum with a definite median keel; hemelytra almost extending to tip of abdomen; male with median notch on hind margin of last abdominal sternite widely rounded; general body color above dark reddish to fuscous brown.

Distribution.—A single specimen from Louisiana: ST. HELENA: one, Liverpool, VIII-13-48, GHP (TU 774). This specimen was taken in a mud-bottomed pot-hole which was filled with turbid, amber-colored, static water exposed to sunlight and with sparse vegetation.

GERRIS ARGENTICOLIS Parshley

Gerris argenticolis Parshley, 1916, Ent. News 27: 103.

Diagnosis.—Generally resembling *G. marginatus;* segment one of antenna longer than two and three united; male with median notch of hind margin of last abdominal sternite semicircular; proximal third of hemelytra with inner margins marked white or yellowish between veins.

Distribution.—Only three collections from Louisiana; these are: IBERVILLE: one, 8 mi. s. Indian Village, XII-16-48, GHP, GHB (TU 810); ST. TAMMANY: two, St. Tammany, IV-29-48, GHP, LLE (TU 210); WASHINGTON: two, Varnado, VI-3-48, LLE (TU 402).

Ecology.—In the three collections *G. argenticolis* was found mostly in temporary water which was clear, amber-colored, static, shaded, mud-bottomed and without aquatic vegetation. Habitats recorded were two ponds and one creek.

GERRIS CANALICULATUS Say

Gerris canaliculatus Say, 1832, Descript. New Sp. Heteropt. Hemipt. North Amer. p. 36.

Diagnosis.—Antenna with segments one and four subequal, segments two and three subequal, each shorter than one; pronotum narrow, with median keel poorly developed; disk with narrowly rounded hind margin; hemelytra extending almost to tip of abdomen when present; general body color dark brown.

Distribution.—This, our most common species of *Gerris,* is widely distributed throughout southeastern Louisiana. The Louisiana records are: ASCENSION: three, Donaldsonville, XII-16-48, GHP, GHB (TU 805); JEFFERSON: one, Waggaman, IV-5-49, GHP (TU 1177); LAFAYETTE: one, Lafayette, IV-2-49, GHB, JFA (TU 470); ORLEANS: five, New Orleans (Audubon Park), IV-8-49, JFA (TU 1160); New Orleans (Penn & Goldsmih, 1950); ST. JOHN: one, Reserve, XI-21-48, GHP, GHB, LLE (TU 855); ST. TAMMANY: one, 10 mi. n. Covington, VIII-10-48, GHP (TU 738); one, 2 mi. w. Goodbee, VIII-31-48, GHP (TU 716); one, 1 mi. s. Sun, VIII-11-48, GHP (TU 747); TANGIPAHOA: seven, 1 mi. e. Amite, X-2-48, GHP, GHB, LLE (TU 115); eleven, 5 mi. e. Ponchatoula, X-2-48, GHP, GHB, LLE (TU 114);

two, Ponchatoula Beach, X-2-48, GHP, GHB, LLE (TU 110); three, Tickfaw, V-7-48, GHP, LLE (TU 219); TERREBONNE: three, 3 mi. n. Boudreaux, X-26-48, GHP, LLE (TU 872); WASHINGTON: three, 3 mi. s. Bogalusa, VIII-11-48, GHP (TU 751); three, 1 mi. s. Rio, VIII-11-48, GHP (TU 749); two, Varnado, VI-3-48, LLE (TU 402); one, 1½ mi. n. Varnado, VIII-11-48, GHP (TU 754).

Ecology.—In a total of seventeen collections with data *G. canaliculatus* was found most commonly in permanent bodies of fresh water (83%) which were exposed (59%), static (82%), clear (77%), amber colored (77%), mud-bottomed (71%) and with aquatic vegetation present (59%). Habitats recorded were ponds (77%), creeks (18%) and bayous (5%).

LIMNOGONUS HESIONE (Kirkaldy)

Tenagogonus hesione Kirkaldy, 1902, Entomologist 35: 137.

Diagnosis.—Antenna long, slender, extending to about hind coxa; eyes slightly concave medially; pronotum much shorter than mesonotum; abdomen shorter than rest of body; fore legs stout, slightly curved with tibia barely longer than femur; mid and hind legs long and slender. Hemelytra surpassing the abdomen. Segment one of antenna barely longer than two and three united.

Distribution.—Only five collections from Louisiana at hand; Torre-Bueno (1911) and Kuitert (1942) recorded it from Louisiana without specific locality data. The records are: ORLEANS: seven, New Orleans (City Park), VII-29-48, GHB (TU 677); PLAQUEMINES: one, 2½ mi. n. DeFeleice, XII-23-48, LLE (TU 833); ST. MARY: two, 5 mi. w. Baldwin, VIII-25-48, GHP (TU 106); ST. TAMMANY: one, 4.7 mi. ne. Covington, VIII-9-48, GHP (TU 728); TANGIPAHOA: one, 1 mi. e. Amite, X-2-48, GHP, GHB, LLE (TU 445).

Ecology.—In a total of five collections this species was found most commonly in permanent bodies of water (100%) which were exposed (100%), static (100%), clear 100%), amber-colored (60%), mud-bottomed (100%) and with aquatic vegetation (60%). The habitats recorded were ponds (80%) and bayous (20%).

METROBATES HESPERIUS Uhler

Metrobates hesperius Uhler, 1871, Proc. Bost. Soc. Nat. Hist. 14: 109.

Diagnosis.—Antenna nearly as long as body; segment one slightly curved, as long as others united; segments two and three enlarged at tip, three shorter than four.

Distribution.—Only three collections from Louisiana; these are: ST. TAMMANY: two, St. Tammany, VII-10-48, A. Hagen (TU 620); one, St. Tammany, IV-29-48, GHP, LLE (TU 210); fourteen, St. Tammany, XI-7-48, LLE (TU 852). All three collections were taken from the same sand-bottomed flowing pineland creek in which the water is usually clear, amber and shaded. Little vegetation is present.

RHEUMATOBATES HUNGERFORDI Wiley

Rheumatobates hungerfordi Wiley, 1923, Canad. Ent. 55: 202.

Diagnosis.—Segment one of antenna small at base and increasing in size to near middle; segment two slenderer than segment one at apex, without spine or tubercle; segment three strongly curved on basal half; segment four bowed with a thick, stout spur just before the middle; pronotum half as long as mesonotum; mid coxa much incrassated and larger than slender hind coxa;

apterous female longer and more robust than male except in the head which is smaller and narrower across the eyes.

Distribution.—Only three collections from Louisiana; these are: JEFFERSON: one, Crown Point, VIII-4-48, GHP (TU 727); ST. TAMMANY: one, 10 mi. n. Covington, VIII-10-48, GHP (TU 738); sixteen, St. Tammany, IV-29-48, GHP, LLE (TU 210).

Ecology.—In three collections this species was found most commonly in permanent bodies of flowing water which was sand-bottomed, clear, amber colored, exposed and with little vegetation. Two of the collections were from creeks in the pinelands, the other from a lowland bayou.

TREPOBATES SUBNITIDUS Esaki

Trepobates subnitidus Esaki, 1926, Ann. Mus. Nat. Hist. Hung. 23: 141.

Diagnosis.—Second and third antennal segments subequal, the third without long hairs; intermediate legs with femur and basal part of tibia clothed with a fringe of hairs whose lengths are subequal to the diameter of the segment at the point where they arise; anterior femur at most only slightly impressed on upper surface before apex; second genital segment without long hairs beneath; length 3.5 mm. in apterous forms.

Distribution.—Only three collections from Louisiana; these are: ST. TAMMANY: one, 4.7 mi. ne. Covington, VIII-9-48, GHP (TU 728); TANGIPAHOA: five, 1 mi. e. Amite, X-2-48, GHP, GHB, LLE (TU 445); one, Tickfaw, V-7-48, GHP, LLE (TU 219).

Ecology.—In three collections this species was found most commonly in permanent bodies which were exposed, static, clear, colorless, mud-bottomed and with aquatic vegetation present. Habitats recorded were two ponds and one bayou.

TREPOBATES PICTUS (Herrick-Schaeffer)

Halobates pictus Herrick-Schaeffer, 1848, Wanz. Ins. 8: 111. *Trepobates pictus* (H-S), Uhler, 1894, Proc. Zool. Soc. London 1894: 213.

Diagnosis.—Head subtriangular; eyes large, located on back of head, diverging posteriorly, resting partly on pronotum; antenna extending beyond middle of the body, segment one shorter than two and three united, two shortest, four longer than three; pronotum short, broader than long in apterous forms, separated from mesonotum; hemelytra when present extending beyond apex of abdomen; fore legs stout, femur slightly bent; mid legs moderately long; hind legs shorter.

Distribution.—No specimens of this species have been collected recently in Louisiana, although Blatchley (1926) listed Louisiana within its range.

TREPOBATES INERMIS Esaki

Trepobates inermis Esaki, 1926, Ann. Mus. Nat. Hung. 23: 4.

Diagnosis.—Posterior margin of mesonotum truncate in apterous form; femur and basal portion of tibia of mid legs in male clothed beneath with long hairs, the lengths of which are subequal to the diameter of the segment bearing them; male claspers short, strongly decurved; segment one of antenna longest, two and three short, each shorter than four.

Distribution.—No specimens of this species have been collected recently in Louisiana, although it was recorded from the state by Drake and Harris (1932).

BELOSTOMATIDAE

BENACUS GRISEUS (Say)

Belostoma griseus Say, 1832, Heteropt. New Harmony p. 37 (complete synonymy in Cummings, 1933, p. 300).

Diagnosis.—Color above dark olive to grayish brown; pronotum with vague light median stripe; pronotum smooth with transverse impressed line across posterior portion; first segment of fore tarsus equal in length to second on outer margin; inner apical angle of under side of posterior tibia not produced into a sharp point; fore femur not grooved, covered with short densely arranged hairs.

Distribution.—It probably occurs throughout the southeastern section of Louisiana. The Louisiana records are: JEFFERSON: one, Avondale, X-10-47, GHP, LLE, JVB (TU 104); one, Metairie, I-23-49, GHP (TU 919); ORLEANS: one, Algiers, XII-3-47, LLE (TU 132); one, New Orleans, XI-27-48, GHP (TU 875); POINTE COUPEE: one, Fordoche, II-5-41, GHP, J. Lancaster (TU P. 23); ST. TAMMANY: one, Indian Village, X-25-36, ESH, GHB (TU P. 112); three, Indian Village, XI-15-36, TFH (TU P. 115); one, 10 mi. s. Slidell, XI-30-37, ESH (TU P. 102).

Ecology.—All except one specimen (TU 104) were taken at night under lights. The lone exception was found in a swamp ditch in water which was amber, clear, static and mud-bottomed. Aquatic plants were *Lemna* sp., and *Alternanthera philoxeroides*.

LETHOCERUS UHLERI (Montandon)

Belostoma uhleri Montandon, 1896, Ann. Soc. Ent. Belgique 40: 513 (complete synonymy in Cummings, 1933, p. 213).

Diagnosis.—General color yellowish brown; interocular space equal to two-thirds width of eye; disk in front lobe of pronotum with median impressed line; hind lobe and scutellum with a vague median keel; length of first segment of fore tarsus one-half that of second as measured on outer margin.

Distribution.—Only two collections on hand, both from the same locality. The Louisiana records are: ORLEANS: one, New Orleans (Lakeview), VII-15-49, GHP (TU 1328); eighteen, New Orleans (Lakeview), VII-20-49, D. W. Farley (TU 1350); New Orleans, IV-30-28 (Cummings, 1933). The two Tulane collections were both made at night under the lights of a theater marquee.

LETHOCERUS AMERICANUS (Leidy)

Belostoma americanus Leidy, 1847, J. Acad. Nat. Sci. Phila. 1 (2): 58, 66 (complete synonymy in Cummings, 1933, p. 213).

Diagnosis.—Color above uniform dull brownish yellow, more or less mottled or streaked; scutellum sometimes with three vague pale spots; under surface yellow dotted with fuscous; front of head with indistinct median keel; interocular space at narrowest point equal to width of eye; inner apical angle of posterior tibia not produced into sharp point; female operculum with two sharp points at apex; male operculum without points.

Distribution.—There are no specimens in the Tulane collections and only one Louisiana record is available: ORLEANS: New Orleans (under light), 1886 (Townsend, 1886).

BELOSTOMA TESTACEUM (Leidy)

Perthostoma testaceum Leidy, 1847, Acad. Nat. Sci. Phila. 1 (2): 60. *Zaitha testaceum* Mayr, 1863, Verb. Zool.-Bot. Ges. Wein. 8: 354.

Diagnosis.—Length less than 25 mm.; head short and obtuse; silken stripe of hairs on connexivum not covering entire mesal area and not touching genital operculum.

Distribution.—Generally distributed throughout the southeastern section of the state. The Louisiana records are: JEFFERSON: two, Bridgedale, Oct. 1936, ESH (TU P. 113); five, Bridgedale, IV-5-39, C. A. Pipkin (TU P. 62); one, Kenner, XI-5-45, ESH (TU P. 8); one, Waggaman, IV-6-48, GHP, LLE (TU 188); one, 3 mi. n. Kenner, III-4-39, E. C. Martin (TU P. 44); LAFOURCHE: three, Raceland, XI-26-48, GHP, LLE (TU 866); LIVINGSTON: one, Springfield, VIII-12-48, GHP (TU 763); MOREHOUSE: one, Galion, VI-24-47, GHP (TU 69); ORLEANS: three, Lee, I-9-48, GHP, LLE, JVB (TU 140, 141); one, Micheaud, I-4-38, GHP, GHB (TU P. 70); two, Micheaud, I-31-37, GHP, GHB, ESH (TU P. 77); two, Micheaud, XI-29-48, GHB (TU 877); one, New Orleans, V-3-45, C. P. Read (TU P. 22); one, New Orleans, III-18-49, JFA (TU 1133); PLAQUEMINES: one, Burrwood, V-31-32, ESH (TU P. 122); one, Delta National Wildlife Refuge, III-9-49, C. G. Whitley (TU 957); three, Fort Jackson, IV-11-37, GHP, ESH (TU P. 83); two, Port Sulfur, XII-23-48, LLE (TU 835); ST. BERNARD: two, Chalmette, XI-19-39, GHP & W. D. Gude (TU P. 56); ST. CHARLES: one, Norco, XII-5-48, J. M. Siekman (TU 889); two, 1 mi. n. Boutte, IV-1-49, GHP, E. N. Lambremont (TU 997); two, 1½ mi. w. Ama. IV-1-49, GHP, E. N. Lambremont (TU 1001); one, 2 mi. w. Ama, III-18-49, GHP, GHB (TU 974); ST. JOHN: one. Reserve, XI-21-48, GHP, GHB, LLE (TU 856); ST. MARTIN: five, Keystone, IV-3-49, GHB, JFA (TU 485); ST. MARY: one, 1 mi. s. Centerville, IV-3-49, GHB, JFA (TU 491); ST. TAMMANY: two, St. Tammany, XI-7-48, GHB, LLE (TU 852); four, Indian Village, X-25-36, GHB, ESH (TU P. 112); one, Indian Village, IX-5-36, TFH (TU P. 106); two, Indian Village, IX-11-36, TFH (TU P. 107); one, Indian Village, IX-20-36, TFH (TU P. 108); two, Indian Village, IX-27-36, TFH (TU P. 109); four, Indian Village, XI-15-36, TFH (TU P. 115); TERREBONNE: two, 1 mi. s. Dulac, XI-26-48, GHP, LLE (TU 874); one, 3 mi. n. Houma, XI-26-48, GHP, LLE (TU 867); two, 1½ mi. s. Dulac, XI-26-48, GHP, LLE (TU 873).

Ecology.—In a total of 22 collections with data, *B. testaceum* was found most commonly in permanent bodies of water (91%) which were exposed (64%), static (86%), clear (77%), amber in color (63%), mud-bottomed (95%) and in which aquatic vegetation was present (81%). Habitats recorded were ditches (48%), ponds (19%), bayous (14%), swamps (9%), marshes (5%) and creeks (5%). Aquatic plants in these habitats in order of their frequency were *Alternanthera philoxeroides, Eichhornia crassipes, Lemna* sp., *Jussiaea* sp., *Typha* sp., *Polygonum* sp., and *Scirpus* sp.

BELOSTOMA FLUMINEUM Say

Belostoma flumineum Say, 1832, Heteropt. New Harmony p. 38. *Zaitha flumineum* Dufour, 1863, Ann. Soc. Ent. Fr., Ser. 4, 3: 388. *Perthostoma boscii* Uhler, *in* Say, 1859, Comp. Writings 1: 365 (in error, Parshley, 1914, Psyche 21: 140). *Zaitha micrantula* Gillette & Baker, 1895, Hemipt. Colo. p. 63 (in error, Parshley, op. cit.).

Diagnosis.—Head conically produced; first segment of beak longer than second; disk of pronotum with many fine transverse wrinkles; scutellum with longitudinal wrinkles at middle of basal portion, transverse wrinkles at and near apex; hemelytra less convergent behind middle than in *lutarium;* wide

silken stripe of hairs on connexivum covering entire mesal area and touching genital operculum.

Distribution.—Recorded without specific locality by Uhler (1876). All Louisiana records to date are restricted to the area between Lake Pontchartrain and the Mississippi river. These records are: JEFFERSON: one, Avondale, X-10-47, GHP, LLE, JVB (TU 104); one, Bridgedale, Oct. 1936, ESH (TU P. 113); ST. BERNARD: one, Chalmette, XI-7-47, GHP, LLE, JVB (TU 125); ST. JOHN: one, Frenier, X-24-47, GHP, LLE (TU 121).

Ecology.—In three collections with data *B. flumineum* was found most commonly in permanent bodies of water which were exposed, static, clear, amber in color, mud-bottomed and with aquatic vegetation present. All collections were made in swamps (ditches and pools). Aquatic plants in these habitats were *Lemna* sp., *Alternanthera philoxeroides* and *Wolffia* sp.

BELOSTOMA LUTARIUM (Stål)

Zaitha lutarium Stål, 1855, Ofv. Sci. Vet.-Akad. Fork. 11: 190. *Belostoma aurantiacum* Bueno & Brimley, 1907, Ent. News 38: 435 (in error, Bueno, 1912, Canad. Ent. 64: 213).

Diagnosis.—Head conically produced; first segment of beak longer than second; tylus convex and more pronounced than in other species; pronotum as in *flumineum*, but with more sinuate sides; hemelytra sparsely punctate; silken stripe of hairs on connexivum covering entire mesal area, not touching genital operculum.

Distribution.—Widely distributed throughout the southeastern part of Louisiana. These records are: EAST BATON ROUGE: three, University, XII-17-48, GHP, GHB (TU 827); IBERVILLE: three, 1 mi. n. Indian Village, XII-16-48, GHP, GHB (TU 813); one, 8 mi. n. Indian Village, II-28-49, A. H. Chaney (TU 950); JEFFERSON: two, Avondale, X-10-47, GHP, LLE, JVB (TU 104); one, Barataria, II-4-49, A. H. Chaney (TU 921); two, Waggaman, III-18-49, GHP, GHB (TU 973); LAFOURCHE: two, DesAllemands, IV-23-37, J. G. Needham, GHB ESH, TFH (TU P. 85); ORLEANS: one, New Orleans (Audubon Park), VIII-30-45, C. Crites (TU P. 127); one, New Orleans (Audubon Park), V-3-37, ESH, TFH (TU P. 87); one, New Orleans (City Park), X-13-48, J. R. Krogsgard (TU 923); one, New Orleans, II-23-49, GHP (TU 946); four, Micheaud, XI-29-48, GHB (TU 877); two, Micheaud, XI-20-36, GHB, ESH, TFH (TU P. 116); POINTE COUPEE: one, Fordoche, II-5-41, GHP, J. Lancaster (TU P. 23); one, Valverda, XI-17-48, GHP, GHB (TU 824); ST. BERNARD: one, Chalmette, I-13-40, GHP, R. T. Perkins (TU P. 27); ST. CHARLES: two, Bonnet Carre Spillway, IV-20-48, GHP, LLE (TU 205); one, Montz, III-15-48, GHP, GHB (TU 151); sixteen, Norco, XII-6-48, GHB (TU 890); seven, St. Rose, III-15-48, GHP, GHB (TU 150); ST. JOHN: two, Reserve, XI-21-48, GHP, GHB, LLE (TU 855); ST. MARY: six, 1 mi. s. Centerville, IV-3-49, GHB, JFA (TU 491); ST. TAMMANY: three, St. Tammany, XI-7-48, LLE (TU 852); TANGIPAHOA: one, 4 mi. e. Ponchatoula Beach, VIII-12-48, GHP (TU 758); one, Tickfaw, V-7-48, GHP, LLE (TU 219); TERREBONNE: two, 1 mi. s. Dulac, XI-26-48, GHP, LLE (TU 874); one, 3 mi. n. Houma, XI-126-48, GHP, LLE (TU 867); WEST BATON ROUGE: one, Alford, XII-17-48, GHP, GHB (TU 819); WEST FELICIANA: one, 9 mi. w. Jackson, I-26-49, GHB, LLE (TU 915).

Ecology.—In a total of 22 collections with data, *B. lutarium* was found most commonly in permanent bodies of fresh water (91%) which were exposed (72%), static (72%), clear (68%), amber in color (66%), mud-bottomed (91%) and in which aquatic vegetation was present (95%). Habitats recorded were bayous (36%), ponds (32%), ditches (23%), swamps

(4%) and creeks (4%). Aquatic plants in these habitats in order of frequency were *Alternanthera philoxeroides*, *Eichhornia crassipes*, *Lemna* sp., *Jussiaea* sp., *Polygonum* sp., *Zizaniopsis miliacea*, *Ceratophyllum* sp., *Azolla caroliniana*, *Myriophyllum* sp., and *Hydrocotyle* sp. One specimen was taken on dry land (TU 946).

BELOSTOMA BAKERI Montandon

Belostoma bakeri Montandon, 1913, Bull. Soc. Sci. Bucarest 22: 123.

Diagnosis.—Head conically produced; well defined convex tylus; first segment of beak shorter than second; pronotum with sides slightly concave; scutellum smooth or finely rugose; hemelytra covering entire abdomen; stripe of hair covering entire mesal area of connexivum, touching genital operculum; color tan to dark brown.

Distribution.—The species has been found to date only in Orleans and Lafourche parishes; perhaps it will prove to be limited to the alluvial parts of southeastern Louisiana. The records are: LAFOURCHE: one, Roux, XII-13-48, GHB, LLE (TU 893); ORLEANS: two: Lee, I-9-48, GHP, LLE, JVB (TU 140, 141); one, Micheaud, XI-29-48, GHB (TU 877); one, New Orleans (City Park), X-13-48, LLE (TU 679); one, New Orleans (City Park), X-13-48, J. Krogsgard (TU 923); two, New Orleans (City Park), III-9-49, JFA (TU 955).

Ecology.—In a total of seven collections, this species was found most commonly in permanent bodies of fresh water (100%) which were exposed (88%), clear (100%), static (100%), amber in color (100%), mud-bottomed (100%) and with aquatic vegetation present (88%). The habitats recorded were ponds (43%), ditches (28%), bayous (14%) and marshes (14%). Aquatic plants in these habitats were *Alternanthera philoxeroides* and *Lemna* sp.

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The Meloidae (Coleoptera) of Texas[1,2]

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The family Meloidae is a relatively small group of beetles, including a few more than three hundred species in America, north of Mexico. Approximately a third of these is known to occur within the boundaries of the State of Texas. While in number of species, then, the group is a minor one, in number of individuals, on the other hand, it is quite an important one for the state, for adults are here abundant on plants, cultivated and native, from early spring to late fall. Quite a number of the forms are pests, attacking cotton, tomatoes, potatoes, beans, sweet potato, and alfalfa; indeed, practically all the major and minor food and forage crops are attacked by meloids to a greater or lesser extent.

This study is based primarily on the collections of the entomology department of the Agricultural and Mechanical College of Texas, and all types and other material listed in the following pages are deposited here unless otherwise indicated. To supplement the above, loans of specimens were obtained from the following institutions and individuals: U.S. National Museum [USNM], American Museum of Natural History [AMNH], Cornell University [CU], University of Kansas [KU], University of Michigan [MU], Ohio State University [OU], California Academy of Science [CAS], and George B. Vogt of Washington, D.C.

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KEY TO SUBFAMILIES

Tarsal claws pectinate ..... Zonitinae
Tarsal claws simple ..... Meloinae

Subfamily ZONITINAE

Head nearly always narrower than prothorax; body form chunkier, less elongate, more compact; maxillae frequently with elongate processes, in many cases filamentous, as long as head or even as long as body, in other cases short, flattened, and scarcely visible. Spurs of protibiae and of mesotibiae unmodified; those of metatibiae usually expanded and truncate or concave apically. Tarsi with claws divided, finely pectinate.

KEY TO TEXAN GENERA

1. Eyes extremely large, more than twice as long as the width of front between eyes; antennae reaching beyond middle of elytra ..... *Pseudozonitis*
   Eyes rather small, not longer than interocular width; antennae not reaching to middle of elytra 2
2. Head at least as long as wide; eye nearly vertical, ovate; antennae distinctly clavate apically ..... *Gnathium*
   Head transverse, usually strongly so; eye transverse, kidney-shaped; antennae not clavate ..... *Nemognatha*

GNATHIUM Kirby

Gnathium Kirby, Trans. Linn. Soc. Lond. 12:425, 1818. Horn, Trans. Amer. Ent. Soc. 3:94, 1870.

Very small, slender beetles. Head elongate, distinctly longer than wide (measured from vertex to apex of clypeus, as the fronto-clypeal suture is obsolete or wanting; from vertex to lower edge of front as measured in the other genera, the head would be at least as long as wide); eyes prominent, nearly vertical, broad, ovate, never greater in height than the width of interocular space; maxillary processes filamentous, at least as long as antennae. Pronotum usually longer than wide, broader than head, widest before middle, strongly narrowed apically. Metatibiae with outer spur broader than inner. Antennae distinctly clavate to apex, rather short, not extending behind basal third of elytra; third segment longest; fourth and first subequal, the latter not extending more than one-third across eye.

Genotype: Gnathium francilloni Kirby, by monotypy.

At various times, it has been proposed by several writers that this genus could not be constantly separated from *Nemognatha* on the characters usually cited. However, the distinctly clavate antennae, the head always at least as long as wide, and the nearly upright and broadly ovate eyes appear to the present writer to warrant its separation. In addition, the clypeus here is closely fused with the front, the suture being obsolete or entirely wanting.

KEY TO TEXAN SPECIES

1. Pronotum nearly impunctate; elytra likewise with only a few distinct punctures ..... *politum*
   Pronotum and elytra distinctly, rather densely punctate 2
2. Head and elytra distinctly uniformly infuscate ..... *francilloni*
   Head and elytra not uniformly infuscate 3
3. Pronotum distinctly longer than wide ..... *minimum*
   Pronotum distinctly wider than long ..... *texanum*

Gnathium politum, new species

Pale testaceous to fulvo-testaceous, shining; very sparsely provided with long, pale brown pubescence.

Head nearly impunctate except between eyes, where it is rather densely, finely punctate, one-sixth longer than wide, sides feebly convergent to eyes; eye subvertical, height equal to about two-thirds of interocular width, prominent, ovate; maxillary filaments much longer than head, reaching apex of abdomen. Pronotum slightly wider than long and much wider than head, sides rather strongly widened from base to apical two-fifths, thence retracted to apex; disk with a few, very fine punctures. Elytra feebly, sparsely, transversely rugulous, sometimes nearly impunctate, sometimes with widely spaced, very shallow, rather coarse punctures, not alutaceous, but with feeble aciculation here and there. Metatibial spurs unequal, outer one strongly concave on inner face, broad, the inner one slender, parallel-sided, straight. Antennae extending to basal fifth of elytra, distinctly clavate; scape scarcely attaining eye, arcuate; second segment nearly two-thirds as long as first; third equal to first, one-third longer than fourth; rest gradually shorter and more robust.

Length: 4 mm.

Holotype: Male and allotype female; Brownwood, June 12, 1932.

Paratypes: Male; Waco. Female; Goldthwaite, Texas, [USNM]. Female; Willow City, Texas, [USNM]. Female; Zephyr, males, 1 female; Brewster Co. [OSU]. 2 males, 1 female, Davis Mts. [OSU]. 1 male, 2 females; Chisos Mts. [OSU]. Occurs from May to September.

Remarks: While this species superficially greatly resembles *G. nitidum* from California, it is at once distinct in the very long maxillary filaments and in having a head of normal length. From other Texan species, it differs moreover, in the smooth, shining elytra, which are nearly impunctate and not at all alutaceous.

GNATHIUM FRANCILLONI Kirby

Gnathium francilloni Kirby, Trans. Linn. Soc. Lond. 12:426, 1818. Horn, Trans. Amer. Ent. Soc. 3:95, 1870. *Gnathium flavicolle* LeConte, Journ. Acad. Nat. Sci. Phila. (2) 4:24, 1858.

Castaneous to fuscous; pronotum testaceous; elytra often castaneous, either entirely or only discally.

Head and pronotum sparsely, rather finely punctate. Head one-sixth longer than wide, sides expanding from vertex to eyes; eye nearly vertical, its height not equal to interocular width, prominent, nearly oval, maxillary filaments as long as antennae. Pronotum one-seventh longer than wide, much broader than head, sides expanded somewhat from base to slightly before middle, thence tapering to apex. Elytra rather coarsely, shallowly, rather sparsely punctate, minutely alutaceous, and feebly. transversely rugulose. Metatibial spurs quite unequal, the outer one broadly lamellate apically, the inner one slender, subspiniform, somewhat arcuate. Antennae distinctly clavate, attaining basal third of elytra; scape reaching one-third across eye, arcuate; second segment one-half as long as first; third nearly as long as first, one-third longer than fourth; remaining segments gradually shorter and thicker.

Length: 3.5-4.5 mm.
Type locality: Georgia [*francilloni*]; Texas [*flavicolle*].
Distribution: Gulf States.
Texan localities: 2; Columbus; [USNM]. 2; Pearsall. 1; Calvert. Occurs in October.

Remarks: This species is most easily identified by the dark head and elytra, the moderate length of the maxillary filaments, by the form of the metatibial spurs, and the sparse punctation of the upper surface.

GNATHIUM TEXANUM Horn

Gnathium texanum Horn, Trans. Amer. Ent. Soc. 3:94, 1870.

Yellowish-testaceous, well covered with sparse, long, brown pubescence. Antennae, abdomen and sterna in part, tarsi and apices of leg segments, infuscated.

Head, except for a median smooth space, and pronotum, rather densely, moderately coarsely punctate; elytra somewhat more densely punctate, densely rugose, and minutely alutaceous. Head a trifle longer than wide (not as long as wide if clypeus is excluded), sides widening to eyes; eye prominent, subvertical, height equal to about two-thirds of interocular width; maxillary filaments about as long as the antennae. Pronotum about one-tenth wider than long, and wider than head, sides rather strongly widened from base to before middle, thence retracted to apex. Metatibial spurs unequal in length, the outer one broader, concave on inner face, the inner one robustly spiniform, concave internally. Antennae attaining basal fifth of elytra, distinctly clavate; scape very short, extending one-fifth across eye, arcuate; second segment two-thirds as long as first; third nearly one-half again as long as first; fourth a little longer than first; fifth and following separately subequal to first, gradually thickened.

Length: 4.5-6 mm.
Type locality: Texas.
Distribution: Texas and Arizona.
Texan localities: 1; Palestine [USNM]. 1; Laredo [USNM]. 3; Brownsville [USNM]. 1; Waco. 1; College Station. 3; Leon Co. [OSU]. 1; Gillespie Co. [OSU]. Occurs from April to June; collected on *Rudbeckia amplexicaulis*, and *Ratipida columnaris*.

Remarks: The distinguishing characteristics of this form are its relatively short head, the pronotum no longer than wide and densely punctate, and the densely punctate elytra, as well as the moderate length of the maxillary filaments.

This species may well prove to be a synonym of *francilloni*.

GNATHIUM MINIMUM (Say)

Nemognatha minima Say, Journ. Acad. Nat. Sci. Phila. 3:171, 1824. *Gnathium minimum* (Say). Horn, Trans. Amer. Ent. Soc. 3:94, 1870. *Nemognatha longicollis* LeConte, Proc. Acad. Nat. Sci. Phila.: 77, 1858.

Yellow-testaceous, sparsely covered with long, brown pubescence. Head in part or in whole fuscous; elytra broadly infuscated on sides and narrowly along suture; antennae, legs in whole or part, and metasternum, sometimes infuscated.

Head and pronotum densely, finely punctate but variable in degree of both density and fineness, usually punctures quite fine and close-set; elytra always more densely and more shallowly punctate, somewhat rugose, and finely coriaceous. Head one-third longer than wide, sides feebly divergent to eyes, which are prominent, sub-vertical, in height subequal to interocular space, ovate, broad; maxillary filaments about one-third longer than the antennae. Pronotum one-tenth longer than wide; wider than head, sides broadly arcuate from base to apex, widest before middle, much narrower at apex. Metatibial spurs equal in length, both concave on inner side, the outer spur usually about twice as broad as inner. Antennae distinctly clavate, reaching slightly beyond base of elytra; scape short, extending one-fourth across eye, arcuate; second segment one-fifth shorter than first; third one-third longer than first; fourth subequal to first; rest slightly shorter, subequal in length, gradually thicker toward apex.

Length: 3.5-6.5 mm.

Type locality: Arkansas [*minimum*]; Ringgold Barracks, Texas [*longicollis*].

Distribution: From Kansas to Texas and New Mexico.

Texan localities: 14, Presidio [USNM-6]. 5; Dimmit Co. [USNM-1]. 1; Winter Haven. 3; Brownsville [USNM]. 4; Robstown [USNM]. 1; Mexia [USNM]. 1; Rosser [USNM]. 1; Paris [USNM]. 1; Canadian [USNM]. 1; Cotulla [USNM]. 1; S. W. Hidalgo Co. [Vogt]. 2; DeLeon. 2; Taylor. 2; Memphis. 2; Bexar Co. 1; Upshur Co. 3; Veleta [CU]. 2; Midland [CU]. 3; College Station [OSU]. 3; Gillespie Co. [OSU]. Occurs from April to August; collected on sunflowers and *Verbesina endeliodes*.

Remarks: This species is characterized by the pronotum being longer than wide, densely finely punctate, by the elytra being very densely punctate, and by the moderately long maxillary filaments.

NEMOGNATHA Illiger

Nemognatha Illiger, Mag. Ins. 6:333, 1807. LeConte, Proc. Acad. Nat. Sci. Phila. 6:345, 1853; Trans. Amer. Ent. Soc. 8:212, 1880. Wellman, Can. Ent. 42:396, 1910.

Small beetles, rather robust, subcylindrical; mostly pale colored forms, elytra sometimes black or with a broad, black vitta. Head strongly transverse, one-fourth or more wider than long, sides usually strongly convergent to eyes, median line wanting; eye rather broad, arcuate, three-fourths or more as long as interocular width; maxillae prolonged into filamentous processes, which vary in length in the several species from as long as labrum to as long as body. Pronotum usually transverse, as wide as head or wider; disk densely punctate (except in *punctipennis*), usually without trace of a median line or impression. Scutellum rather large for the family, broadly triangular, apically rounded. Elytra broadly and feebly tumid on each disk behind base. Legs moderate in length; metatibial spurs usually flattened or concave apically. Antennae usually extending behind basal third of elytra, rather slender; scape short, not extending behind middle of eye, arcuate; second segment somewhat shorter than first; third variable, frequently subequal to first; and fourth subequal to third.

Genotype: Zonitis chrysomelina Fabricius, designated by Wellman, 1910.

Remarks: It will be noted that the small-eyed American species, formerly

placed in the genus *Zonitis* on the basis of the short maxillary filaments, are removed to this genus, as the length of these filaments is inconstant. It may be that all the members of this genus may have to be placed in the Old World genus *Zonitis*, but the final solution of the problem lies beyond the scope of the present paper.

KEY TO TEXAN SPECIES

1. Maxillary filaments shorter (or scarcely longer) than head 2
   Maxillary filaments much longer than head, usually reaching at least to metacoxae 8
2. Pronotum almost entirely devoid of punctures; elytra very coarsely punctate ..... *immaculata*
   Pronotum distinctly punctate; elytra rather finely, densely punctate 3
3. Head entirely black 6
   Head never entirely black 4
4. Tibiae and tarsi entirely fuscous, rest of body red ..... *rufa*
   Tibiae and tarsi not entirely fuscous, rest of body yellowish or fuscous 5
5. Pronotum with well-spaced coarse punctures; elytra entirely fuscous ..... *brunneopennis*
   Pronotum densely punctate 7
6. Prothorax yellow ..... *zonitoides*
   Prothorax black ..... *atra*
7. Pronotum with sides narrowed from base to apex; labrum about as long as wide, it and the clypeus together not longer than front ..... *vittigera*
   Pronotum with sides strongly arcuate, widest medially; labrum distinctly longer than wide, it and the clypeus together longer than front ..... *cribricollis*
8. Metatibiae with outer spur two or three times as broad as inner 9
   Metatibiae with outer spur about equal in width to inner 10
9. Upper surface feebly shining; pronotum, at least towards sides, densely minutely punctulate or alutaceous ..... *lurida*
   Upper surface polished; pronotum at most very sparsely, minutely punctulate near sides, usually devoid of minute sculpturing ..... *pallens*
10. Maxillary filaments attaining apex of abdomen ..... *piezata*
    Maxillary filaments not reaching much behind metacoxae ..... *bicolor*

NEMOGNATHA LURIDA LeConte

Nemognatha lurida LeConte, Proc. Acad. Nat. Sci. Phila. 6:345, 1853. Trans. Amer. Ent. Soc. 8:212, 1880.

Robust, fulvous, covered with rather long, black pubescence. Body beneath in large part blackish; antennae, legs (except femora sometimes), and often scutellum, blackish or fulvous. Elytra in one specimen from San Antonio black at apex.

Upper surface rather finely and densely punctate, minutely, rather densely punctulate, and obsoletely alutaceous; elytra more densely and finely punctate. Head nearly one-half again as broad as long, sides strongly convergent to eye, usually without a median impression; clypeus and labrum together about three-fifths as long as front; eye nearly equal to interocular width, about as broad as infraocular space; maxillary processes extending to or beyond metacoxae; maxillary palpus nearly as long as mandible. Pronotum distinctly broader than long and slightly broader than head, sides usually narrowed from base, rounded at apical fifth (or at apical fourth less usually); disk with median basal impression obsolete or wanting. Outer metatibial spur about three times as broad as inner, apex concave, triangular, widened distally, inner one deeply concave and elongate-ovate at apex. Antennae reaching

nearly to middle of elytra; scape extending almost one-half across eye; second segment two-thirds as long as, and third slightly longer than, first; fourth feebly shorter than third; fifth distinctly shorter than fourth; remaining segments gradually diminishing in length.

Length: 12-13 mm.
Type locality: Platte River, Missouri.
Distribution: Central States.
Texan localities: 1; Gainesville [USNM]. 1; Big Springs [USNM]. 1; Presidio [USNM]. 1; Del Rio [USNM]. 1; San Antonio [USNM]. 1; Dallas [MU]. 4; McLennan Co. 1; McKinney. 5; Donna. 4; Taylor. 2; College Station. 1; Hidalgo Co. 10; Carrizo Springs [AMNH]. 2; Oklaunion [AMNH]. 1; Edinburgh [AMNH]. Occurs in June and July; recorded as being found on sunflower.

Remarks: Distinguished from *pallens* by its more robust form and by the form of the metatibial spurs.

NEMOGNATHA PALLENS LeConte

Nemognatha pallens LeConte, Proc. Acad. Nat. Sci. Phila. 6:346, 1853. *Nemognatha lutea* LeConte, Proc. Acad. Nat. Sci. Phila. 6:346, 1853; Trans. Amer. Ent. Soc. 8:213, 1880.

Luteous to deep fulvous, shining, covered sparsely with long, blackish, erect pubescence. Antennae (except basal segments sometimes), tibiae, tarsi, and sometimes femora, blackish; sternum to a greater or lesser degree, abdomen in part, and often scutellum, blackish or fuscous. Elytral apices sometimes infuscate.

Upper surface rather finely, sparsely punctate, elytra more finely and densely so. Head three-fifths wider than long, sides strongly tapering to eyes; clypeus and labrum together not so long as front; eyes in length about equal to interocular width, slightly broader than infraocular space; maxillary processes extending nearly to or beyond metacoxae, maxillary palpus as long as mandible. Pronotum one-seventh shorter than wide, about as wide as head, form variable, campanuliform or with sides straight and parallel on basal two-thirds, thence arcuate to apex; disk often with a median impression behind middle. Outer metatibial spur broad and concave at apex, twice as broad as inner, which is somewhat flattened, subparallel-sided. Antennae attaining basal third of elytra; scape reaching two-fifths across eye, arcuate; second feebly shorter than first; third one and one -half times as long as second; fourth slightly shorter than third, remaining segments gradually diminishing in length.

Length: 9-13 mm.
Type locality: California [*pallens*]; *Missouri* [*lutea*].
Distribution: Throughout the west-central and Pacific coast states.
Texan localities: 2; Presidio [USNM]. 4; Hereford [USNM]. 1; McAllister [USNM]. 1; Progress [USNM]. 1; Laredo [USNM]. 1; Forth Worth [USNM]. 1; Navasota. 2; College Station. 2; Brownwood. 1; Edinburgh [AMNH]. Occurs from March to August; found on potato, alfalfa, and *Helianthus ciliaris.*

Remarks: N. pallens has page precedence over *lutea* and hence the usual synonymy must be reversed.

Distinguished by the form of the metatibial spurs, the rather long maxillary processes, and the short palpi. From *lurida* it is further distinguished in having the upper surface scarcely punctulate and not at all alutaceous.

NEMOGNATHA PIEZATA (Fabricius)

Zonitis piezata Fabricius, Ent. Syst., Suppl.: 104, 1798. *Nemognatha piezata* (Fabricius). LeConte, Proc. Acad. Nat. Sci. Phila. 6:347, 1853; Trans. Amer. Ent. Soc. 8:213, 1880. *Zonitis vittata* Fabricius, Syst. Eleuth. 2:24, 1801. *Nemognatha texana* LeConte, Proc. Acad. Nat. Sci. Phila. 6:347, 1853. *Nemognatha punctulata* LeConte, Proc. Acad. Nat. Sci. Phila. 6:347, 1853.

Fulvous to reddish-brown, covered with sparse, rather long, black pubescence; elytra occasionally with a broad, sinuous, black vitta from near base to apex; body beneath entirely pale or entirely black or fuscous. Antennae, legs (except femora sometimes), occasionally scutellum, and portions of mouth parts, black or fuscous.

Upper surface rather finely and densely punctate, minutely, rather densely punctulate, and in small part alutaceous; elytra much more densely and finely punctate. Head one-third again as broad as long, sides strongly convergent to eyes, median impression wanting; labrum and clypeus together three-fifths as long as front; eye in length equal to interocular width, about as broad as infraocular space; maxillary processes attaining apex of abdomen; maxillary palpus not so long as mandible. Pronotum slightly wider than long, wider at base than head; variable in form, sides often straight, tapering from base to apical fifth, thence rounded into apical margin; disk occasionally with a median impression before base. Outer metatibial spur similar in size and shape to the inner, both short, concave on inner face. Antennae extending beyond basal third of elytra, rather robust; scape reaching nearly halfway across eye; second segment two-thirds as long as first; third only slightly longer than second; fourth as long as first, remaining gradually shorter.

Length: 8-13 mm.

Type locality: North America [*piezata, vittata*]; Texas [*texana*].

Distribution: Atlantic and southern states.

Texan localities: 1; Box [USNM]. 1; Childress [USNM]. 1; Wichita Falls [USNM]. 3; Sanderson [USNM—2; AMNH—1]. 6; Brownsville [USNM]. 3; Alpine [USNM]. 1; Del Rio [USNM]. 1; Cotulla [USNM]. 1; Marfa [USNM]. 1; McLennan Co. 6; Waco. 3; Fort Worth. 1; Weslaco. 2; Taylor. 1; Forestburg [MU]. Occurs from April to July.

Remarks: Duffers from *lurida* and *pallens* in having the metatibial spurs subequal, the maxillary filaments always as long as body, and in having the fourth antennal segment longer than third.

It was impossible to separate *punctulata* from this species; the punctation and form of the pronotum are too inconstant to warrant their use in speciation.

NEMOGNATHA BICOLOR LeConte

Nemognatha bicolor LeConte, Proc. Acad. Nat. Sci. Phila. 6:345, 1853; Trans. Amer. Ent. Soc. 7:213, 1880. *Nemognatha discolor* LeConte, Proc. Acad. Nat. Sci. Phila. 10:77, 1858.

Black or fuscous, rather densely blackish pubescent; pronotum and head above bright testaceous, sparsely pubescent.

Upper surface rather coarsely, densely punctate, elytra more finely and densely so. Head two-fifths wider than long, sides distinctly convergent to eyes, median impression wanting; clypeus and labrum together three-fourths

as long as front; eye equal to two-thirds interocular width, much narrower than infraocular space; maxillary filaments reaching to metacoxae or nearly so; maxillary palpus shorter than mandible. Pronotum one-seventh wider than long, quite distinctly wider than head, sides parallel, hind and front angles broadly rounded. Metatibial spurs short, similar in size and form, feebly impressed at apex. Antennae extending beyond basal third of elytra; scape reaching a little more than one-third across eye; second segment three-fourths as long as, and third one-fourth longer than, first; fourth slightly shorter than third; remaining segments gradually decreasing in length.

Length: 7-11 mm.
Type locality: Missouri territory [*bicolor*]; Texas [*discolor*].
Distribution: From Kansas and Colorado into Texas.
Texan localities: 7; Taylor. 18; College Station [OU—2]. 2; Bexar Co. 1; Dimmit Co. 2; Karnack [OU]. 1; Clarendon [USNM]. 1; New Braunfels [USNM]. 1; Corpus Christi [USNM]. 1; Cotulla [USNM] 1; Dallas. Occurs from April to August.

Remarks: Easily recognizable by the coloration, by the pronotum being distinctly wider than head, with rounded hind angles, by the form of the metatibial spurs, and by the dense pubescence of the elytra.

NEMOGNATHA VITTIGERA LeConte

Nemognatha vittigera LeConte, Proc. Acad. Nat. Sci. Phila. 6:348, 1853. *Zonitis perforata* Casey, Ann. N. Y. Acad. Sci. 6:170, 1871.

Light fulvous to dark ferruginous, relatively densely covered with short, erect pubescence, that on pronotum distinctly denser than that on elytra. Elytra each occasionally with a broad fuscous or black vitta from behind base to near apex. Legs frequently with apices of femora, and entire tibiae and tarsi fuscous; antennae and abdomen feebly at times fuscous.

Head and pronotum densely, finely, and usually uniformly punctate; elytra rather coarsely, strongly rugosely punctate. Head nearly one-third wider than long, sides strongly convergent to eyes, front with a scarcely visible median sulcus; eye in length subequal to interocular width, about as broad as infraocular space; maxillary filament only slightly longer than maxillary palpus, which is distinctly longer than mandible. Pronotum slightly wider than long and wider than head, sides nearly straight or weakly bisinuous, somewhat tapering to apex; disk sometimes with a median anterior smooth area and a posterior broad sulcus. Metatibial spurs subequal, concave and ovate apically, the inner spur a little narrower than outer. Antennae reaching middle of elytra; scape nearly extending to middle of eye; second segment about two-thirds as long as first; third slightly shorter than first, to which the fourth is equal; fifth and sixth subequal, as long as third; rest gradually shorter

Length: 7-13 mm.
Type locality: Georgia [*vittigera*]; Austin, Texas [*perforata*].
Distribution: Indiana and Georgia west to Arizona.
Texan localities: 1; Menard. 1; Navasota. 1; Catauna, 1; Timpson [USNM]. 1; Gurley [USNM]. 2; Alpine [USNM]. 1; Cotulla [USNM]. 2; New Braunfels [USNM]. 1; Dallas [USNM]. 1; San Antonio [USNM]. 6; Forestburg [NU]. 4;

Laredo. 4; Taylor. 2; Matador. 3; College Station. 1; Sherman. 2; Fort Davis [AMNH]. 1; Edinburgh. On sunflower in June.

Remarks: Distinguished from the other forms with short maxillary processes in having the pronotum more densely pubescent than elytra, the metatibial spurs subequal, the eyes as wide as front, and by the nearly straight, feebly tapering sides of the pronotum.

It was impossible, in the short series available for study, to satisfactorily separate *perforata* from *vittigera;* some differences in the density and coarseness of elytral punctation do exist in these two nominal forms, but no distinction could be made between them.

NEMOGNATHA CRIBRICOLLIS LeConte

Nemognatha cribricollis LeConte, Proc. Acad Nat. Sci. Phila. 6:348, 1853; Trans. Amer. Ent. Soc. 8:215, 1880. *Nemognatha porosa* LeConte, Proc. Acad. Nat. Sci. Phila. 6:349, 1853. *Nemognatha fuscipennis* LeConte, Proc. Acad. Nat. Sci. Phila. 6:349, 1853.

Fulvous, rather densely covered with very short, erect pubescence, that on pronotum shorter and finer, but not much denser than that on elytra. Antennae, tarsi, and sometimes the tibiae, fuscous.

Upper surface moderately coarsely and not so densely punctate, elytra finely, densely, and rugosely punctate. Head one-fourth wider than long, rounded from vertex to eyes, without trace of median impression; eye about three-fourths as long as interocular width, not quite so broad as infraocular space; labrum distinctly longer than wide, it and clypeus together slightly longer than front; maxillary filament not much longer than maxillary palpus, which is about as long as mandible. Pronotum at middle one-sixth wider than long, and one-sixth wider than head; sides strongly arcuate to apex, sinuate at base; disk without any impressions. Metatibial spurs broad, concave at apex, subequal, the inner one blunt, the outer subacute. Antennae reaching beyond basal third of elytra; scape extending a little more than halfway across eye; second segment three-fifths as long as first; third subequal to first; fourth one-fifth shorter than third; rest subequal, shorter than fourth.

Length: 5-8 mm.

Type locality: Texas [*cribricollis*]; Georgia [*porosa*]; St. Louis, Mo. [*fuscipennis*].

Distribution: The southern and south-central states.

Texan localities: 18; College Station. 2; Waco. 1; Gainesville [USNM]. 1; Tyler [USNM]. 2; Taylor. 2; Glenn Spring [MU]. 1; Colorado Co. Occurs from April to June.

Remarks: This species is closely allied to *vittigera* but is distinct in having the sides of the pronotum strongly arcuate and in having the labrum elongate, combined length of latter and the clypeus equal the length of the front.

NEMOGNATHA IMMACULATA Say

Nemognatha immaculata Say, Journ. Acad. Nat. Sci. Phila. 1:22, 1817. LeConte, Trans. Amer. Ent. Soc. 8:214, 1880. *Zonitis dunniana* Casey, Ann. N. Y. Acad. Sci. 6:170, 1891.

Luteous, body devoid of distinct pubescence except on head. Antennae (except basal segments), tarsi, and apices of femora, fuscous.

Upper surface smooth, except for the finely punctate front and the very coarse, scattered punctures on the elytra. Head one-third wider than long, sides distinctly convergent to eyes, impressed line wanting; clypeus and labrum together equal to three-fifths length of front; eye equal to about two-thirds interocular width, not quite so broad as infraocular space; maxillary filaments attaining mesocoxae. Pronotum usually feebly wider than long, sometimes strongly so, sides subparallel, usually weakly bisinuate, rarely broadly arcuate; disk often with a short longitudinal sulcus behind middle. Metatibial spurs concave and ovate apically, the inner one much finer than outer. Antennae attaining basal fourth of elytra; scape not quite reaching middle of eye, arcuate; second segment three-fifths as long as first; third a little shorter than first; fourth slightly shorter than third; rest subequal and one-fifth shorter than fourth.

Length: 8-12 mm.

Type locality: Plains west of the Missouri [*immaculata*]; El Paso, Texas [*dunniana*].

Distribution: Known from Arizona and the panhandle of Texas.

Texan localities: 4; Clarendon [USNM]. 1; Plainview. Occurs in August and September; known to feed on *Grindelia aquarrosa*.

Remarks: The smooth, glabrous pronotum, the glabrous, coarsely punctate elytra, and the rather short maxillary filaments will distinguish this species.

NEMOGNATHA ZONITOIDES Dugès

Nemognatha zonitoides Dugès, La Naturaleza 3:47, pl. 2, fig. 1, 1874; An. Mus. Michoacano 2:110, 1889. Champion, Biol. Centr.-Amer. Col. (2):379, pl. 17, f. 15, 1892.

Fuscous to black; entire prothorax and sometimes abdomen in whole or in part, yellow. Scutellum dull rufous or fulvous.

Head densely, rather finely punctate, very slightly broader than long, sides arcuately narrowed to mandibles; eyes prominent, about four-fifths as long as interocular width, two-thirds as broad as infraocular space; muzzle elongated; maxillary filaments slightly longer than the mandibles. Pronotum as long as wide, distinctly wider than head, campanuliform, widest in front of middle and narrowest at apex; disk covered, except along a broad median longitudinal space, with fine, widely spaced punctures. Elytra subrugosely and very densely, finely punctate. Metatibial spurs short, subequal, on inner face broadly concave, expanded somewhat to before apex. Antennae reaching nearly to middle of elytra, slender; scape extending about one-third across eye, arcuate; second segment one-fifth shorter than first; third about one-eighth longer than first; fourth equal to first; remaining segments slightly shorter than fourth.

Length: 7-9 mm.

Type locality: Guanajuato, Mexico.

Distribution: Central America to Texas and Arizona.

Texan localities: 2; Carlsbad Highway [USNM]. 1; Presidio [USNM]. 2; Davis Mts. [OU]. Occurs in August and September; captured on *Fallugia paradoxa*.

NEMOGNATHA ATRA (Dugès)

Gnathium atrum Dugès, An. Mus. Michoacano 2:113, 1889. *Nemognatha atra* (Dugès). Champion, Biol. Centr.-Amer. Col. 4(2):380, 1892.

Black or piceous, shining, very sparsely fuscous pubescent.

Head and pronotum sparsely, finely punctate; head nearly one-third wider than long, sides strongly convergent to mandibles; eyes arcuate, reniform, length equal to five-sixths the interocular width; maxillary filaments as long as head. Pronotum wider than head, one-fifth broader than long, sides subparallel, gradually narrowed from apical third to anterior margin; disk with a feeble median subbasal impression. Elytra moderately finely, rather densely punctate and distinctly but not roughly rugulose. Metatibial spurs short, subconcave on inner face, outer spur slightly longer and more robust than inner. Antennae reaching to basal fifth of elytra; scape extending one-third across eye, robust, clavate, arcuate; second segment three-fourths as long as first; third segment one-fourth longer than first; fourth shorter than third; fifth and following subequal, slightly shorter than fourth.

Length: 9 mm.
Type locality: Tupatara, Mexico.
Distribution: Texas and Mexico.
Texan locality: "*Texas*" [CU].

Remarks: At once distinguished from other Texan forms by the uniform black, shining appearance.

Nemognatha brunneopennis, new species

Testaceous; elytra dark orange-brown, lighter apically; antennae fuscous; tibiae, tarsi, and metasternum more or less infuscate. Rather sparsely clothed with fuscous pubescence, elytra more densely covered with longer pubescence.

Head rather densely coarsely punctate except broadly on middle of front, distinctly transverse, sides rather strongly convergent to mandibles; eyes prominent, three-fourths as long as interocular distance, about as wide as infraocular space; maxillary filaments slightly longer than head from vertex to tip of mandibles. Pronotum slightly wider than long and wider than head, sides broadly arcuate from prominent basal angles to apex, widest before middle and narrowest at apex; disk coarsely, sparsely punctate. Elytra rather feebly, transversely rugulose, with fine, rather dense punctures at base, which become rapidly sparse and shallow to apical third, where they are more or less obsolete. Metatibial spurs equal, short, on inner face obliquely and deeply concave. Antennae extending to basal third of elytra; scape reaching one-third across eye, distinctly arcuate; second segment nearly one-fourth shorter than scape; third segment equal to first; remaining segments shorter.

Length: 8 mm.
Holotype: female; Texas [USNM].
Paratypes: female; Chisos Mts. [OU]. Female; Davis Mts. (J. N. Knull) [OU].

Remarks: This form is most closely related to *cribricollis*, but is readily distinguished by the color of the elytra and by the sparser punctation of both the pronotum and elytra.

NEMOGNATHA RUFA (LeConte)

Zonitis rufa LeConte, Proc. Acad. Nat. Sci. Phila. 7:85, 1854.

Fulvous, orange-fulvous, or reddish, sparsely covered with reddish pubescence; pronotum nearly glabrous. Antennae, palpi largely, tibiae, tarsi, and at least apex of femora, fuscous.

Head rather coarsely, densely punctate, distinctly wider than long, sides strongly convergent to mandibles; eyes small, not much more than half as long as interocular width, two-thirds as wide as infraocular space; maxillary filaments scarcely perceptible. Pronotum distinctly transverse (male), or as long as wide (female), visibly wider than head, sides arcuately expanded to apical two-fifths, thence strongly retracted to the very narrow apical margin; disk sparsely, rather finely punctate. Elytra densely rugulose. Metatibial spurs short, impressed on inner face, inner spur shorter than outer. Antennae reaching to basal third of elytra in female, just to base in male, nearly uniform in width throughout; scape extending only one-sixth across eye; second segment more than three-fourths as long as first; third distinctly longer than first; fourth and following slightly shorter than third segment in male, subequal to third in female.

Length: 6-8 mm.

Type locality: Frontera, Texas.

Distribution: Texas.

Texan localities: 2; Texas [USNM]. 1; Lyford, Feb. 21, 1920 [USNM]. 1; Brazos Co., April 5, 1941.

Remarks: This species is easily distinguished by the small eyes, reddish coloring, and the dark tibiae and tarsi.

Pseudozonitis, new genus

Small or medium-sized, rather slender beetles; maculation of pronotum and elytra similar to that of the Lampyridae. Head very strongly transverse, at least one-fourth wider than long, sides strongly convergent; eye prominent, very large, two or more times as long as interocular width, often more closely approximate below than above; maxillary processes broad, not filiform and never much longer than mandibles. Pronotum usually wider than long, broader than head, sides typically expanded from the prominent hind angles to before middle, thence narrowed to apex. Legs moderate in length; metafemora strongly robust; metatibial spurs flattened or concave apically. Antennae reaching beyond middle of elytra, slender; scape short, not extending beyond middle of eye, arcuate; second segment shorter than first; third subequal to first; fourth to sixth always distinctly longer than first.

Genotype: Zonitis longicornis Horn.

Remarks: Related to *Nemognatha* but is at once distinguished by the immensity of the eye. Moreover, the maxillary processes are broad and never longer than the mandibles, and the fourth to sixth antennal segments are distinctly longer than the first.

Among non-Texan species which should be placed here are *martini* Fall, *vigilans* Fall, *schaefferi* Blatchley, *vittipennis* Horn, and *arizonica* Van Dyke.

KEY TO TEXAN SPECIES

1. Eyes more closely approximated below than above 2
   Eyes not so closely approximated below as above 4
2. Elytra uniformly gray-brown; head entirely castaneous ..... *castaneis*
   Elytra not uniformly colored; head not entirely brown 3
3. Pronotum with a conspicuous median fuscous macula ..... *longicornis*
   Pronotum very vaguely maculate with darker ..... *pallidus*

4. Elytra fuscous or piceous, with margins and sometimes a median vitta, pale; pronotum with an irregular median rosaceous macula ..... *roseomaculatis*
Elytra entirely pale; pronotum with an obtriangular fuscous macula at middle ..... *vogti*

Pseudozonitis vogti, new species

Body rich dark brown, somewhat paler on the underparts. Pronotum orange-red, with a large, median, inverted, elongate-triangular, dark macula. Elytra pale testaceous.

Head and pronotum rather densely, finely punctate, but with a number of smooth areas interspersed; elytra very densely, finely, rugosely punctate. Head more than one-third wider than long, sides strongly convergent to mandibles; front with a deep fovea each side just below level of eyes; eyes prominent, more than twice as long as interocular width, about as widely separated below as above; maxillary processes about as long as the palpi. Pronotum one-fifth wider than long, distinctly wider than head, sides constricted near base, widened to before middle, thence tapering strongly to apex, disk with a distinct median basal sulcus and a pronounced impression each side of middle near apex. Metatibial spurs subequal, both obliquely truncate at apex, the truncature feebly concave. Antennae slender, extending to apical third of elytra; scape reaching nearly two-fifths across eye, slightly arcuate; second and third segments nearly as long as first; fourth one-third longer than first; fifth a little longer, and sixth slightly shorter, than fourth; remaining segments subequal to each other and to fourth.

Length: 8 mm.

Holotype: Male; Starr Co., Texas, April 6, 1947 [George B. Vogt].

Remarks: Closely related to *martini* Fall described from Arizona, but here the elytra are pale testaceous, not fuscous, and the median dark spot of the pronotum is quite large.

Pseudozonitis roseomaculatis, new species

? *Zonitis schaefferi* Blatchley, Can. Ent. 54:28, 1922.

Dull luteous, sparsely covered with short, luteous and fuscous pubescence. Head largely fuscous except below, sometimes pale above as well, leaving a dark area between eyes. Pronotum with a bright rosaceous median macula extending from base to apex, which is expanded strongly at base. Scutellum mostly fuscous. Elytra largely dull fuscous, sutural and lateral margins and frequently a median vitta, pale; sometimes the pale margins are wanting. Antennae fuscous, with very narrow, basal, pale annulations. Legs with tibiae on apical half and tarsi entirely fuscous, rest pale, sometimes femora infuscate medially. Sternum and abdomen in part infuscated.

Entire upper surface densely, finely punctate; elytra very densely and rugosely so. Head one-fourth wider than long, sides strongly, arcuately convergent to mandibular bases; eye slightly prominent, about twice as long as interocular width, not so approximate below as above, as broad as infraocular space; maxillary processes about as long as mandibles. Pronotum one-fifth wider than long, much broader than head, sides nearly straight and feebly expanded on basal three-fifths, thence strongly retracted to apex, basal angles prominent; disk broadly impressed each side before middle. Metatibial spurs

short, subequal, apices obliquely truncate and concave. Antennae extending behind middle of elytra; scape reaching nearly halfway across eye; second segment one-sixth shorter than first; third equal to first; fourth one-third longer than third, fifth still longer; sixth as long as fourth, remaining segments gradually shorter.

Length: 8-13 mm.

Holotype male, *allotype* female, and 19 *paratypes:* Bexar Co., (H. B. Parks). 1 *paratype;* Dimmit Co., May, 1933. 2 *paratypes;* College Station [CU]. 1 *paratype;* Kingsville [CU].

Remarks: This form may prove to be identical to *P. schaefferi* from Florida but differs from the original description of that species in having the antennae distinctly longer, reaching beyond the middle of elytra; the pronotum not merely tinged with rosaceous but with a well-defined rosy macula; the legs pale to a much greater extent; the under surface not blackish; and the elytra apparently more densely punctate.

Pseudozonitis pallidus, new species

Light fulvous or pale ferrugineous; elytra fuscous to a greater or lesser degree, frequently only dimly so, the margins and an oblique median vitta remaining pale. Pronotum with several poorly defined rosaceous or darkish maculae. Legs pale, apices of femora and tibiae fuscous; antennae and tarsi fuscous, with bases and apices of segments pale.

Entire upper surface densely, rather finely punctate, elytra more densely so. Head about one-fourth wider than long, sides strongly convergent to bases of mandibles; eyes prominent, large, about two and one-half times as long as interocular width, closely approximated beneath, as broad as infraocular space, much wider posteriorly; maxillary processes about as long as the labrum. Pronotum about as long as broad, slightly wider than head, sides widened to before middle, thence narrowed to apex, hind angles prominent; disk sometimes broadly impressed on each side of middle, especially anteriorly. Metatibial spurs subequal, short, both strongly obliquely truncate at apex, with a median elevation on truncature. Antennae slender, extending well behind middle of elytra; scape reaching nearly halfway across eye, arcuate; second segment one-fifth shorter than first; third equal to first; fourth to sixth each one-third longer than first; remaining segments gradually diminishing in length.

Length: 14-17 mm.

Holotype male, *allotype* female, and 3 *paratypes:* College Station, June 5-17, 1934 (H. J. Reinhard). 4 *paratypes;* Morris Co., June 27, 1937. 3 *paratypes;* Madison Co., July 29, 1931. 1 *paratype;* Dimmit Co., May 30, 1934. 1 *paratype;* Tyler, Oct. 5, 1937.

Remarks: Related to *roseomaculatis* but in the present form the eyes are closely approaching, and the body coloring, even where infuscated, has a faded-out appearance and is generally quite pallid. The relative lengths of the antennal segments are likewise distinct.

PSEUDOZONITIS LONGICORNIS (Horn)

Zonitis longicornis Horn, Trans. Amer. Ent. Soc. 3:93, 1870.

Luteous or pale testaceous, with fuscous markings as follows: Head with

a quadrate macula on front and a transverse one on clypeus. Pronotum with a subdivided macula occupying much of disk and a smaller one on the deflexed sides. Elytra with most of disk occupied by a large macula, more or less divided by a pale stripe which attains neither base nor apex. Underside and antennae mostly fuscous; abdomen with pale bands. Legs pale in color; bases of femora, apices of tibiae, and tarsi except for pale annulations, fuscous.

Upper surface densely, rather finely punctate, the head more finely, the elytra more densely so. Head nearly one-half again as wide as long, sides strongly tapering to base of mandibles; eyes enormous, prominent, occupying much of head, nearly contiguous below, about four times as long as interocular width, broader than infraocular space; maxillary processes broad, scarcely as long as mandibles. Pronotum feebly wider than long and wider than head, sides subparallel on basal three-fifths, thence strongly convergent to apex; disk broadly impressed each side near apical one-fourth, basally with a short, deep median sulcus. Metatibial spurs subequal, short, convex and oval apically. Antennae slender, extending behind middle of elytra; scape arcuate, reaching one-third across eye; second segment one-fifth shorter than first; third as long as first; fourth and sixth one-fourth longer than third; remaining segments feebly shorter than fourth.

Length: 12-14 mm.
Type locality: Central Illinois.
Distribution: Illinois to Florida and Texas.
Texan localities: 2; Laredo; [USNM]. 2; Weslaco Co. 1; Hidalgo Co. 3; Klagsville [CU]. 2; Brownsville [CU; OSU].

Remarks: The large eyes, long antennae, dark central marking on pronotum, and elytral coloration will distinguish this species.

Pseudozonitis castaneis, new species

Bright castaneous, sparsely covered with short, pale pubescence. Pronotum bright yellow, with a small, dark brown macula before center. Scutellum dull brown-yellow. Elytra bright grayish-brown. Legs and antennae reddish-brown, with fuscous pubescence.

Head medially smooth, above with fine, very sparse punctation; between eyes densely, coarsely punctate, about one-half wider than long, sides strongly, arcuately convergent to mandibles; eyes prominent, nearly three times as long as interocular width, approximated beneath, slightly decurved around antennal insertions, nearly as wide as infraocular space; maxillary processes a little longer than labrum. Pronotum about one-third wider than long, feebly wider than head, sides sinuately widened from base to apical third, thence arcuately retracted to the very narrow apical margin; disk moderately densely, finely punctate, more sparsely so toward apex, median sulcus distinct, nearly entire. Elytra densely, deeply, rugosely punctate. Metatibial spurs flattened, truncate apically, the inner spur longer and distinctly more robust than outer. Antennae slender, reaching beyond middle of elytra; scape extending two-fifths across eye, feebly arcuate; second segment one-fifth shorter than first;

third very slightly shorter and fourth a little longer than first; fifth slightly longer than fourth, to which the rest of the segments are subequal.

Length: 6.5 mm.

Holotype: Male?; Presidio, Texas, April 2, 1945, on *Sphaeralcea angustifolia* [U.S.N.M.].

Remarks: This species is amply distinguished from others of the large-eyed members of the genus by the coloration, the elytral punctation, and form of the metatibial spurs.

Subfamily MELOINAE

Head usually wider than prothorax; body form variable, globose or elongate-cylindrical. Maxillae unmodified. Spurs of pro- and mesotibiae as well as those of the metatibiae, often variously modified or entirely absent. Tarsi with the claws divided but not pectinate.

KEY TO TRIBES

1. Profemur beneath with a patch of dense, silky pubescence ..... *Epicautini*
   Profemur beneath without a dense sericeous patch 2
2. Metasternum short, the mesocoxae partially overlapping the metacoxae ..... *Meloini*
   Metasternum elongate, the mesocoxae widely separated from the metacoxae 3
3. Pronotum strongly tumid behind, transversely depressed anteriorly ..... *Tegroderini*
   Pronotum planate, neither tumid nor transversely depressed ..... *Lyttini*

Tribe LYTTINI

Body usually elongate, except in *Tetraonyx*. Head slightly narrower or wider than prothorax, strongly transverse, usually subtriangular; front planate, sometimes with a median sulcus above but sculpturing otherwise simple. Eye variable in size and position, transverse in *Pyrota*, strongly oblique in the remaining genera, usually with posterior portion broader than the anterior. Pronotum subplanate, never strongly tumid posteriorly nor depressed anteriorly. Elytra fully developed, sometimes highly sculptured; hind wings present and normal. Legs moderate or rather short, the first two pairs subequal, the hind ones slightly longer; profemora without a patch of sericeous hairs, metafemora not nearly attaining apex of elytra. Antennae rather short, scarcely surpassing elytral base, filiform, moniliform, or slightly clavate, often highly modified in male; scape nearly always short (except in *Pyrota*).

KEY TO TEXAN GENERA

1. Eye nearly as long or much longer than interocular width; pronotum distinctly longer than wide ..... *Pyrota*
   Eye always much shorter than interocular width; pronotum as long as wide or strongly transverse 2
2. Pronotum one-half wider than long; entire upper surface covered with sparse erect hairs ..... *Tetraonyx*
   Pronotum never much broader than long; at least the elytra glabrous 3
3. Pronotum with sides parallel ..... *Pomphopoea*
   Pronotum suborbicular ..... *Lytta*

TETRAONYX Latreille

Tetraonyx Latreille, in Humboldt & Bonpland, Obs. Zool. 1:160, 1811. Lacordaire, Gen. Col. 5:673, 1859. Hoag, Stett. Ent. Zeit.:249, 1879. Horn, Trans. Amer. Ent. Soc. 12:116, 1885.

Short, robust, rather small. Head strongly transverse, sides convergent to eyes, front with an impressed median line above; eyes rather small, subovate, slightly emarginate above antennal insertion. Pronotum more than one-third again as wide as long, and wider than head, anteriorly strongly constricted; disk convex, impressed posteriorly. Scutellum moderate in size. Elytra (in Texan species) finely punctate, not rugulose nor alutaceous; hind wings present, normal in length. Abdomen frequently strongly shortened, not nearly attaining apex of elytra. Legs rather short, hind ones longer but metafemora not nearly attaining apex of elytra. Metatibial spurs concave on inner face, not truncate apically; metatarsal claws elongate, strongly arcuate. Antennae rather short, scarcely attaining base of elytra, thickened apically from fourth segment; scape reaching one-fourth across eye; second segment one-third as long as first, third slightly longer than second; fourth and following subequal, longer than third, but shorter than first.

Genotype: Tetraonyx octomaculatus Latreille, by monotypy.

Remarks: In body form and habitus, the members of this genus resemble those of the genus *Nemognatha,* but lack, of course, the pectinate tarsal claws.

KEY TO TEXAN SPECIES

Front uniformly fulvous; femora and tibiae fulvous, with apices black ..... *fulvus*
Front black, except above; legs entirely black ..... *frontalis*

TETRAONYX FULVUS LeConte

Tetraonyx fulva LeConte, Proc. Acad. Nat. Sci. Phila. 6:344, 1853. Horn, Trans. Am. Ent. Soc. 12:116, 1885. Haag, Stett. Ent. Zeit.:288, 1879. Champion, Biol. Centr.-Amer. Col. 4(2):392, 1892. *Tetraonyx rufus* Dugès, La Naturaleza 1:105, pl. 4a, fig. 7, 1869.

Fulvous, covered rather sparsely with erect, fulvous hairs. Antennae, tarsi, apices of femora and tibiae, and entire under surface, black or piceous.

Entire surface of body and legs finely, densely punctate. Head one-fourth wider than long, sides strongly convergent to eyes, above with a median groove from occiput to middle of front; eyes small, very broadly ovate, suberect, in length equal to scarcely more than half the interocular width, about as broad as infraocular space. Pronotum nearly one-half again as wide as long, at base wider than head, sides feebly narrowing from base to near apical third, thence strongly constricted to apex, which is about one-third as broad as base; disk rather tumid, with a deep transverse impression medially at base. Metatibial spurs concave on inner face, feebly expanded towards apex, outer spur slightly broader and a triflle longer than inner. Protarsi in male expanded, first segment angularly produced mesad. Antennae robust, somewhat thicker from fourth segment; scape arcuate, extending one-fourth across eye; second segment one-third as long as first; third half as long as first; fourth and following segments subequal, slightly longer than third.

Length: 8-13 mm.

Type locality: New Mexico [*fulvus*]; Guanajuato, Mex. [*rufus*].

Distribution: New Mexico and West Texas to the northern highlands of Mexico.

Texan localities: 11; Presidio. 2; Castolon. 2; El Paso [CU]. Occurs from April to October.

Remarks: The foregoing was the only species of this genus encountered

among all the material available. However, Horn reported *frontalis* as occurring in the State; this species differs from the present one chiefly in the color of the legs and front.

LYTTA Fabricius

Lytta Fabricius, Syst. Ent.:260, 1875. Leconte, Proc. Acad. Nat. Sci. Phila. 6:330, 1853 [ex parte]. *Cantharis* Geoffroy [non Linné]. Champion, Biol. Centr.-Amer. Col. 4(2):437, 1892. Fall, Trans. Amer. Ent. Soc. 27:293, 1901.

Elongate-oblong, convex, mostly moderate to large species. Head wider than long, sides subparallel or converging to eyes; latter oblique, broadly ovate, not as long as width of front; labrum feebly emarginate. Pronotum usually slightly wider than long, never longer than wide, subequal to head in width; disk usually without median line. Elytra usually rugulose; hind wings present. Metatibiae, except in *convexa* and related forms, with the outer spur much more robust than inner. Sixth sternite usually deeply notched at apex in male, truncate apically in female. Antennae rather short, only slightly surpassing elytral base, segments submoniliform, often stouter apically; scape not extending behind middle of eye, second segment about one-fourth as long as first; third and following somewhat shorter than first.

Genotype: Cantharis vesicatoria Linné, designated by Escherich, 1894.

KEY TO TEXAN SPECIES

1. Elytra fulvous or orange-brown 2
   Elytra black or blue-black 5
2. Pronotum black ..... *fulvipennis*
   Pronotum pale fulvous or orange-brown 3
3. Head above black; elytra each with a dark macula at basal fourth and a larger one at apical third ..... *quadrimaculata*
   Head pale above; elytra at most with a single macula 4
4. Body beneath entirely black; elytra immaculate ..... *lecontei*
   Body beneath at least in part pale; elytra each with a subapical macula (rarely absent) ..... *biguttata*
5. Pronotum entirely black 6
   Pronotum at least in part reddish or pale 8
6. Metatarsal spurs equal in size ..... *convexa*
   Metatarsi with outer spur at least twice as broad as inner 7
7. Head above red; elytra without elevated lines ..... *eucera*
   Head above black; elytra with coarse, reticulating, elevated lines ..... *reticulata*
8. Pronotum entirely reddish; elytra nearly smooth ..... *mutilata*
   Pronotum reddish only on sides; elytra with fine reticular lines ..... *cribrata*

LYTTA EUCERA (Chevrolat)

Cantharis eucera Chevrolat, Col. Mex. I, fasc. iii, (52), 1834. Horn, Proc. Am. Phil. Soc. 13:104, 1873. Champion, Biol. Centr.-Amer. Col. 4(2):438, 1892.

Black; vertex of head broadly reddish, the median line black.

Body above with very sparse, fine punctures, minutely alutaceous, the head obsoletely and the elytra heavily so, the latter subrugose as well. Head much wider than long, sides strongly convergent to eyes; latter scarcely more than half as long as interocular width, ovate, not so broad as infraocular area. Pronotum one-seventh broader than long, nearly as wide as head, sides nearly straight, strongly expanded from base to apical two-fifths, thence strongly constricted to apex. Protibiae with two spurs in both sexes, the anterior one

more robust and feebly longer; metatibiae with outer spur broadly ovate apically, obtuse, the inner spur parallel-sided, about one-third as broad as outer; metatrochanter unarmed. Sixth sternite apically broadly emarginate and with a tuft of hairs each side in male. Antennae in male reaching to basal sixth of elytra, robust, fourth to sixth segments strongly produced laterally at apex, subpectinate; scape reaching to middle of eye; second segment one-fourth as long and third four-fifths as long as first; fourth subequal to first; remaining segments gradually shorter.

Length: 24 mm.
Type locality: Mexico.
Distribution: Texas and Mexico to Panama.
Texan localities: 1; Texas [USNM].

LYTTA MUTILATA (Horn)

Cantharis mutilata Horn, Trans. Amer. Ent. Soc. 5:155, 1876; ibid, 10:310, 1883. Champion, Biol. Centr.-Amer. Col. 4(2):439, 1892.

Head (except below), prothorax, scutellum in part, and metepisterna in part, red; rest black or fuscous.

Head and pronotum densely, minutely punctulate and with sparse, fine punctures. Pronotum and elytra minutely alutaceous, the latter subrugose as well. Head disitnctly broader than long, sides strongly convergent to eyes; latter about three-fifths as long as interocular width, distinctly narrower than infraocular space. Pronotum one-eighth wider than long, feebly wider than head, sides arcuately expanded to apical two-fifths, thence strongly constricted to apex. Protibiae with two spurs in both sexes, the anterior one distinctly longer; metatibiae with outer spurs suborbicular at apex, nearly three times as broad as the sublinear inner spur. Metatrochanter unarmed. Sixth sternite distinctly emarginate apically in male and with a tufted lobe each side, in female feebly emarginate. Antennae attaining pronotal base, gradually thickened in female, the fourth to sixth segments expanded internally in male, the fifth excavated; scape reaching halfway across eye; second segment about two-fifths as long as first; third and fourth subequal, nearly as long as first; remaining segments gradually shorter. In the female the third and fourth segments each are only three-fifths as long as first.

Length: 14-25 mm.
Type locality: Arizona.
Distribution: Mexico, Arizona, and Texas.
Texan localities: 1; Alpine [USNM]. 3; Presidio [USNM]. Occurs in August and September.

LYTTA QUADRIMACULATA (Chevrolat)

Cantharis quadrimaculata Chevrolat, Col. Mex. 1:79, 1834. Horn, Proc. Am. Phil. Soc. 13:105, 1873. Champion, Biol. Centr.-Amer. Col. 4(2):440, 1892.

Black; head with median frontal spot, pronotum, and elytra yellow-fulvous. Pronotum with two discal maculae and a smaller spot on each side, blackish. Elytra each with an irregular macula at basal fourth joining the dark portion of suture, and a much larger, oblong macula at apical third, fuscous. Tibiae and tarsi orange-brown. Abdomen with sides of apical sternites yellow-fulvous.

Upper surface minutely punctulate and rather densely, finely punctate; elytra subrugose as well. Head much wider than long, sides strongly convergent to eyes; latter about three-fifths as long as interocular width, broadly ovate, about as broad as supraocular space. Pronotum as wide as long, not quite as wide as head, sides subparallel nearly from base to apex, narrowly constricted at each end. Protibiae with two spurs in each sex, the anterior one much longer and stouter than posterior one; metatibiae with outer spur robust, its apex suborbicular, obliquely truncate, inner spur shorter and slender. Antennae distinctly surpassing elytral base, fourth to sixth segments enlarged in male; scape reaching two-fifths across eye; second segment one-fourth as long and third four-fifths as long as first; fourth and fifth nearly as long as first; sixth and following subequal to third segment.

Length: 17 mm.
Type locality: Toluca, Orizaba, Mexico.
Distribution: Texas and Mexico.
Texan localities: 1; Texas [USNM].

LYTTA BIGUTTATA LeConte

Lytta biguttata LeConte, Proc. Acad. Nat. Sci. Phila. 6:332, 1853. *Cantharis biguttata* (LeConte). Horn, Proc. Am. Philos. Soc. 13:109, 1873.

Luteous to orange-fulvous; head except for a macula on front, sternum to a greater or lesser extent, antennae, and scutellum, black. Pronotum usually with two rounded maculae on disk and a much smaller one each side, fuscous or black. Elytra with basal portion of suture and a macula on apical fourth of disk, fuscous. Legs with femora apically and often entire tibiae, infuscate.

Surface nearly smooth, shining, obsoletely alutaceous and with a few scattered, rather coarse punctures, fairly densely pubescent; elytra somewhat rugulose. Head broader than long, sides feebly arcuately convergent to eyes; latter about three-fifths as long as interocular width, broadly ovate, as broad as supraocular space. Pronotum broader than long, nearly as wide as head, sides arcuately widened to before middle, thence strongly narrowed to apex; basal margin strongly notched at middle. Protibiae with two spurs in both sexes, the anterior one much longer than the posterior; metatibiae with outer spurs robust, its apex truncate, concave, broadly ovate, longer than inner, which is narrow, and acute. Sixth sternite deeply emarginate in both sexes, in female with a process each side. Antennae attaining base of elytra, segments four to six more or less thickened in both sexes; scape reaching one-fourth across eye; second segment about one-quarter as long as first; third and fifth three-fourths as long and fourth almost as long, as first; remaining segments gradually shorter.

Length: 7-12 mm.
Type locality: Santa Fe, New Mexico.
Distribution: New Mexico, Arizona, West Texas, and Mexico.
Texan localities: 1; Sanderson [USNM]. 2; Alpine [USNM]. 4; Presidio [USNM—3]. 4; Ft. Davis [MU]. 1; The Basin, Big Bend Park [AMNH]. Occurs from May to July.

LYTTA RETICULATA Say

Lytta reticulata Say, Journ. Acad. Nat. Sci. Phila. 3:305, 1824. LeConte, Proc. Acad. Nat. Sci. Phila. 6:332, 1853.

Piceous or black; head, pronotum, legs, and antennae often mahogany brown in whole or part.

Entire body densely, minutely alutaceous. Head and pronotum densely, irregularly, rather finely punctate. Head subquadrate, slightly wider than long, sides subparallel, feebly rounded to eye; latter broad, ovate, length about three-fourths the interocular width, distinctly broader than infraocular space but not so broad as supraocular area. Pronotum subglobose, as long as wide, slightly broader than head, broadest at apical two-fifths, strongly constricted apically. Elytra entirely covered by a coarse network of elevated lines. Protibiae in both sexes with two arcuate spurs, the anterior one feebly longer; metatibiae with the outer spur very robust, truncate apically, truncature excavated, ovate, subacute, inner spur about one-third as broad, flattened apically. Metatrochanters unarmed. Sixth sternite at apex angularly notched in male, arcuately emarginate in female. Antennae robust, more strongly so in male, gradually thicker from base, attaining base of pronotum; scape reaching one-third across eye, robust; second segment one-half, and third two-thirds, as long as first; fourth nearly as long as first; remaining segments feebly gradually shorter, except last, which is slightly elongate or ovate.

Length: 12-23 mm.

Type locality: Arkansas.

Distribution: From Kansas and Colorado to Texas and New Mexico.

Texan localities: 4; Brownfield, Terry County. 2; Lamesa, Dawson County. 1; Canadian [USNM]. 1; Presidio [USNM]. Occurs from April to July; found on wild morning-glory.

Remarks: Distinguished from all other known species by the reticulating elevated lines on the elytra.

LYTTA FULVIPENNIS LeConte

Lytta fulvipennis LeConte, Proc. Acad. Nat. Sci. Phila. 6:331, 1853.

Fuscous or black, elytra pale fulvous to red-fulvous. Head with a median frontal yellow macula.

Above rather densely, finely punctate; head and pronotum minutely punctulate, and elytra densely alutaceous and subrugulose. Head slightly wider than long, sides convergent to eyes; the latter three-fourths as long as interocular width, broadly ovate, slightly broader than infraocular space but not so broad as supraocular area. Pronotum suborbicular, as long as wide, not quite so wide as head. Protibiae with two subequal spurs in both sexes; metatibiae with outer spur robust, truncate and concave apically, apex subrotund, much longer than inner spur, which is sublinear. Sixth sternite at apex deeply notched in male, truncate in female. Antennae attaining base of elytra, gradually thickened apically in both sexes; scape reaching one-third across eye; second segment one-fourth as long and third two-thirds as long as first; fourth and following segments subequal to third.

Length: 14-27 mm.

Type locality: Texas and Mexican Boundary.
Distribution: Texas.
Texan localities: 1; Luling [USNM]. 2; Austin [USNM; MU]. 1; New Braunfels [USNM]. 1; Victoria [USNM]. 1; San Antonio [USNM]. 3; Taylor. 4; Dilley. 6; Bell Co. 5; Temple. 4; Hillsboro. 4; Zephyr. 1; McLennan Co. 1; Burnet Co. [MU]. 2; Edinburgh [MU]. 2; Tarrant Co. [MU]. 21; S. W. Hidalgo Co. [G. B. Vogt]. Occurs from March to September.

LYTTA LECONTEI Heyden

Lytta dichroa LeConte, Proc. Acad. Nat. Sci. Phila. 6:332, 1853. Fall, Trans. Amer. Ent. Soc. 27:398, 1902 [non *Lytta dichroa* Fisch, 1823]. *Lytta lecontei* Heyden, Wien. Ent. Zeit. 9:132, 1890.

Head above except occiput, pronotum except on basal margin, and elytra, luteous or orange-fulvous; rest black or fulvous. Pronotum with a round, blackish macula each side of middle of disk.

Above minutely, subobsoletely alutaceous and with scattered, rather fine punctures. Head subquadrate, distinctly wider than long, sides distinctly convergent to the eyes; the latter broadly ovate, nearly three-fourths as long as interocular width, nearly as broad as supraocular area. Pronotum about one-fifth wider than long, about as wide as head, sides strongly arcuate, widest just anterior to middle, strongly constricted apically. Elytra indistinctly punctate, subrugose. Protibiae with two spurs in both sexes, the anterior one slightly longer and more robust; metatibiae with the outer spur very robust, apical truncature broad, nearly circular, the inner spur much shorter than outer and about one-fourth as broad, flattened on inner face. Metatrochanters unarmed. Sixth sternite deeply notched apically in male, truncate in female. Antennae reaching nearly to base of elytra, gradually wider from base, a little more robust in male than in female; first segment extending one-third across eye, robust; second segment not quite half, and third two-thirds, as long as first; fourth and following segments subequal to third.

Length: 14-19 mm.
Type locality: Mexican Boundary.
Distribution: Texas and Mexico.
Texan localities: 4; Bell Co. 4; Taylor. 1; McKinney Co. 1; Brownsville [USNM]. 1; Bishop [USNM]. 1; Alamo [USNM]. 1; Dallas Co. [MU]. Occurs from March to June; on alfalfa.

LYTTA CRIBRATA LeConte

Lytta cribrata LeConte, Proc. Acad. Nat. Sci. Phila. 6: 447, 1853. *Cantharis pilsbryi* Skinner, Ent. News, 17:217, 1906. [new syn.]

Black; head with a large frontal macula and pronotum with sides, except at base and apex, broadly orange-red.

Body above minutely obsoletely alutaceous and with a few scattered, coarse punctures; elytra roughly rugulose. Head distinctly broader than long, sides nearly straight, subparallel; eyes about three-fifths as long as interocular width, broadly ovate, distinctly broader than infraocular area. Pronotum suborbicular, wider than long and broader than head. Protibiae with two subequal spurs in both sexes; metatibiae with outer spur robust, apex obliquely truncate, concave, and broadly ovate, about twice as broad as inner spur, which is rather slender, tapering. Sixth sternite in female truncate at apex.

Antennae slightly surpassing elytral apex, gradually thickened to apex; scape reaching two-fifths across eye; second segment one-fourth and third segment three-fourths as long as first; fourth and fifth slightly longer than third, remaining segments gradually decreasing.

Length: 21 mm.
Type locality: Texas [*cribrata*]; Pecos River, Texas [*pilsbryi*].
Distribution: Texas.
Texan localities: 1; Chinati Mts; Oct. 12.

LYTTA CONVEXA LeConte

Lytta convexa LeConte, Proc. Acad. Nat. Sci. Phila. 6:336, 1853.

Bluish-black or fuscous.

Upper surface densely, minutely alutaceous and with scattered, coarse punctures; elytra strongly rugulose. Head much broader than long, sides broadly arcuately convergent to below eyes, median sulcus distinct to middle of front; eye suberect, about two-thirds as long as interocular width, about as broad as infraocular space. Pronotum broader than long, not quite so broad as head, sides slightly widened to before middle, then arcuately constricted to apex; disk with a deep, subtransverse impression at base. Protibiae in male without spurs, in female hind spur strongly curved, longer than anterior one; metatibial spurs slender, spiniform, flattened on inner face, outer spur distinctly shorter than inner. Profemora in male with a stout tubercle on lower surface near base. Sixth sternite angularly notched at apex in male, truncate in female. Antennae not attaining base of pronotum, segments not moniliform, subquadrate, gradually wider apically; scape nearly reaching halfway across eye; second segment one-third, and third two-thirds, as long as first; remaining segments subequal, about three-fourths as long as third.

Length: 8-12 mm.
Type locality: Mexican Boundary.
Distribution: Colorado to Texas.
Texan localities: 5; Presidio [USNM—2]. 1; Alpine [USNM]. 1; Marfa [USNM]. 1; El Paso [USNM]. 4; Marathon [MU]. Occurs from June to October; on *Applopappus spinulosus.*

POMPHOPOEA LeConte

Pomphopoea LeConte, Smiths. Misc. Coll. 136:273, 1862; Ibid. 167:161, 1866.

Moderate-sized, slender, metallic-green species. Head much broader than long, median impressed line obsolete or wanting; eyes small, not much more than half so broad as front; labrum prolonged, deeply bilobedly emarginate. Pronotum as long as wide, distinctly but not strongly narrower than head, sides narrowed anteriorly; disk planate. Tibiae more or less arcuate, especially the middle ones; metatibial spurs robust, truncate and concave apically, the outer one broader than inner; tarsi slender, the last segment as long as first, intermediate segments shorter, claws with divisions equal in length. Antennae rather short, feebly surpassing elytral base, apical segments gradually thickened, submoniliform, first three or four segments cylindrical; scape short, not reaching beyond middle of eye; second segment short; third and fourth nearly as long as first segment.

Genotype: LeConte in his original description failed to name any species

belonging in his new genus; in 1866, however, he published a synopsis of the species. Among those included in this later work was *Lytta aenea* Say, which is herewith designated as type.

KEY TO TEXAN SPECIES

1. Elytra with scattered hairs on disk ..... *aenea*
   Elytra with hairs only on side margin and apex 2
2. Legs rufous, tarsi and trochanters (and sometimes tibiae) blackish ..... *texana*
   Legs rufous, femora at apex, tibiae at base and apex, and tarsi blackish ..... *sayi*

POMPHOPOEA TEXANA LeConte

Pomphopoea texana LeConte, Smiths. Misc. Coll. 167:161, 1866.

Deep metallic green with a brassy sheen, legs ferruginous, tarsi and trochanters infuscated (as are the tibiae in some specimens). Antennae blackish.

Upper surface minutely, densely alutaceous and with scattered, coarse punctures; elytra strongly rugulose as well; head and pronotum hirsute, elytra with short hairs along side margins and apically, disk entirely glabrous. Head one-third wider than long, sides more or less distinctly convergent to eyes, median line smooth; eyes small, very little more than half as long as interocular width, about as broad as infraocular space. Pronotum as long as wide, one-ninth narrower than head, sides subparallel to apical third, thence strongly narrowed to apex; disk sometimes with an indistinct median line near center, basal impression feeble.

Pro- and metatibiae nearly straight, mesotibiae strongly arcuate; protibiae with two short spurs in both sexes; metatibial spurs short, truncate and excavated at apex, the outer one somewhat more robust than inner. Antennae attaining base of elytra, apical segments gradually thickened, submoniliform; scape reaching nearly one-half across eye; second segment one-third as long as, and third one-seventh shorter than, first; fourth and fifth segments as long as third; remaining gradually decreasing in male, in female fourth and fifth shorter than third.

Length: 12-18 mm.
Type locality: Texas.
Distribution: Texas.
Texan localities: 1; Dallas [USNM]. 1; San Antonio [USNM]. 1; Ranger [USNM]. 2; Austin. 3; Comanche Co. 3; Iowa Park. 1; Gatesville. 20; College Station. 1; Bryan. Occurs in March and April.

Remarks: Only the present form was represented from Texas in the material studied; reports of other forms occurring in the region may be based on misdeterminations, but are included in the key to species, nevertheless.

PYROTA LeConte

Pyrota LeConte, Journ. Acad. Nat. Sci. Phila. (2) 1:91, 1848; Smiths. Misc. Coll. 136:273, 1862; op. cit. 167:159, 1866. Horn, Trans. Am. Ent. Soc. 12:112, 1885. Casey, Ann. N. Y. Acad. Sci. 6: 173, 1891. Champion, Biol. Centr.-Amer. Col. 4(2):428, 1892. Denier, Rev. Soc. Ent. Arg. 6:49, 1934.

Elongate, moderately slender, mostly moderate in size; body coloring mostly yellowish, usually spotted or vittate with blackish; upper surface subglabrous. Head wider than long; eyes transverse, varying from somewhat shorter to much longer than interocular width. Pronotum always longer than wide, narrowed anteriorly, sides usually broadly arcuate; disk almost always

without trace of a median line, at base with a small, distinct impression. Elytra each with four fine costae, surface usually rugulose. Abdomen with sixth segment broadly and irregularly impressed at apex in male, usually notched in female. Tibiae with spurs simple in both sexes, spiniform; metatibiae with at least outer spur robust, obliquely truncate at apex, concave, variable in the various species. Antennae relatively short, robust, seldom extending much beyond base of elytra; scape (except in *postica*) not extending behind eye, at apex obliquely truncate; the second segment usually one-fourth as long as first, articulating with it near outer angle, causing the antennae to appear subgeniculate; third segment shorter than first; remaining ones usually subequal. Maxillary palpi in male variable in shape in the different species, sometimes unmodified, sometimes greatly expanded, transverse, securiform.

Genotype: Pyrota palpalis Champion [= *Lytta mylabrina* LeConte, *non* Chevrolat], herewith designated.

Remarks: This genus is the most highly diversified member of the tribe, differing in form of eye, pronotum, and antennae.

KEY TO TEXAN SPECIES

1. Elytra immaculate, uniformly pale ..... *victoria*
   Elytra maculate, vittate, or banded, or entirely dark 2
2. Elytra with at least a median or postmedian dark fascia 3
   Elytra maculate or vittate, not fasciate 9
3. Antennae with scape extending strongly beyond hind margin of eye; elytra with a broad postmedian fascia but without a distinct apical band ..... *postica*
   Antennae with scape never extending beyond hind margin of eye, usually not attaining it; elytra usually with an apical fascia 4
4. Elytra with apical band usually narrow, lunate, distinctly separated from the apical edge by a pale margin, band sometimes absent, median fascia with inner lobe distinctly produced anteriorly ..... *punctata*
   Elytra with apical band attaining apical edge, median fascia with inner lobe never produced basad 5
5. Elytra with median fascia occupying two-fifths length of disk, basally each with two maculae, the humeral one very small or absent ..... *engelmanni*
   Elytra with median fascia extending across only one-fifth the elytral length, each basally usually with a fascia, or if bimaculate, the outer macula nearly as large as inner 6
6. Metatibiae with both spurs rather robust, the outer one not twice as broad as inner, which is oval at apex; male with terminal segment of palpi scarcely enlarged, about equal to half width of labrum ..... *perversa*
   Metatibiae with inner spur less than half as broad as outer, usually slender, not oval (except in *concinna*); male with terminal segment of palpi strongly expanded, transverse, at least as wide as labrum 7
7. Eyes much longer than interocular width, distinctly broader than infraocular space and as broad or broader than supraocular area; elytra with median fascia usually much broader than pale spaces between it and other dark markings, basal band not usually divided into two maculae 8
   Eyes at most equal to interocular width, about as wide as infraocular space and distinctly narrower than supraocular area; elytra with median band narrower than pale spaces between it and other dark markings, basally with two well separated maculae ..... *mylabrina*
8. Elytra with surface densely, minutely alutaceous, especially apically, subopaque; east and south Texas ..... *palpalis*
   Elytra with surface scarcely alutaceous even apically, shining; west Texas ..... *concinna*

9. Elytra with suture dark 10
Elytra with suture pale 11
10. Head in great part pale, scutellum, legs, and body beneath blackish ..... *invita*
Head, scutellum, legs largely, and body beneath in part, yellowish ..... *discoidea*
11. Elytra disk entirely black, shining, narrowly margined with reddish ..... *akchurstiana*
Elytra not as above 12
12. Elytra with disk largely dusky, with a short, oblique vitta at base, a small macula near apex, and entire margin, pale ..... *insulata*
Elytra not so 13
13. Elytra each with a single dark vitta, close to lateral edge of disk, and usually with a macula near scutellum ..... *tenuicostatis*
Elytra each bivittate 14
14. Elytral vittae black, shaply defined, distinctly narrower than pale space between them ..... *bilineata*
Elytral vittae fuscescent, poorly defined, somewhat broader than pale space between them ..... *lineata texana*

PYROTA PUNCTATA Casey

Pyrota punctata Casey, Ann. N. Y. Acad. Sci. 6:173, 1891. Champion, Biol. Centr.-Amer. Col. 4(2):430, pl. 20, fig. 2, 1892. Denier, Rev. Soc. Ent. Arg. 6:64, 1934.

Shining, light ochraceous, the elytra pale luteous; maculate with black as follows: Head immaculate, except sometimes on occiput, the labrum often infuscate. Pronotum with two discal rounded or ovate maculae, variable in size. Scutellum infuscate basally, rarely apically as well, or immaculate. Elytra each with two well-separated basal maculae, the outer one elongate, narrow, the inner one much broader, ovate or oblong, about one-third shorter than the outer, behind middle a fascia of two lobes, the inner one extending distinctly basad of the outer, which often extends further caudad than inner, before apex a lunate fascia (sometimes absent or reduced) which is distinctly separated from the apical margin. Body beneath variable, sternum often largely black or with irregular maculae, abdomen frequently with a broad, black band covering most of first five sternites, sometimes reduced to maculae on first, fourth, and fifth segments. Legs with apices of femora and tibiae, and entire tarsi, black. Palpi and antennae (except for part of scape) black.

Head broader than long, coarsely, sparsely, and finely, rather densely punctate; impressed line wanting; eyes broad, distinctly broader than infraocular space, longer than interocular distance. Pronotum much longer than wide, sides arcuate, narrower apically; disk with several longitudinal series of coarse punctures, median line visible only at base, basal impression shallow or obsolete. Elytra with four feeble costae, surface sometimes polished, sometimes minutely rugose and subopaque. Palpi in male with terminal segment slightly enlarged, narrowly triangular, about three-fourths as wide as labrum. Antennae attaining base of elytra, feebly tapering apically, scape nearly reaching to middle of eye; second segment one-fourth as long as first; third segment two thirds as long as first, either a little shorter or a little longer than fourth; rest subequal in length.

Length: 12-22 mm.
Type locality: West Texas.
Distribution: Arizona to West Texas and Mexico.
Texan localities: 3; Big Bend Park. 1; Castolon. 9; Presidio [USNM—3]. 3; Dim-

mit Co. 3; San Angelo. 1; College Station. 1; Cotulla [USNM]. 3; El Paso [USNM]. 3; Kingsville [CU]. Occurs from April to September; on *Speralceia angustifolia*.

Remarks: Distinguished from the other fasciate species by the form of the apical band of the elytra, by the removal of this band from the apical margin, and by the form of the median fascia.

The specimens from the central portion of the State have the elytra less shining and the abdomen less strongly marked with black than more western examples.

PYROTA CONCINNA Casey

Pyrota concinna Casey, Ann. N. Y. Acad. Sci. 6:174, 1891. Denier, Rev. Soc. Ent. Arg. 6:56, 1934.

Exactly as in *P. palpalis* except as follows: Color tending to be a little paler; elytra polished.

Entire upper surface with minute punctules obsolete or absent. Elytra with surface nearly smooth between punctures, only obsoletely alutaceous. Metatibiae with outer spur rather acute at apex. Antennae slightly surpassing base of elytra, tapering from fourth segment; scape reaching nearly across eye in male, slightly shorter in female; second segment one-fourth length of first; third about three-fifths as long as first; rest of segments gradually shorter. Maxillary palpi in male less strongly transverse, chunkier than in *palpalis*, the anterior borders strongly emarginate.

Length: 10-14 mm.

Type locality: West Texas.

Distribution: West Texas.

Texan localities: Big Bend Region. 1; Weslaco. 6; Presidio [USNM—4]. 1; Ysleta [USNM]. 5; Van Horn [MU]. Occurs in August and September.

Remarks: On the basis of the structure of the male maxillary palpi, there is some doubt that the form here described is actually *concinna*, for Casey described the species as one in which the palpi were unmodified. However, as the sexes are otherwise difficult to separate without dissection, the present writer felt that, as Casey's description applies so fully in every other detail, it was not unlikely that he had misdetermined the sex of his material.

PYROTA POSTICA LeConte

Lytta mylabrina β LeConte, Journ. Acad. Nat. Sci. Phila. (2) 4:22, 1858. *Pyrota postica* LeConte, Smiths. Misc. Coll. 167:160, 1866. Horn, Trans. Amer. Ent. Soc. 12:113, pl. 5, f. 15, 1885. Casey, Ann. N. Y. Acad. Sci. 6:173, 1891. Champion, Biol. Centr.-Amer. Col. 4(2):431, pl. 20, f. 5, 1892. Denier, Rev. Soc. Ent. Arg. 6:64, 1934.

Luteous, shining; head, sometimes pronotum, and legs ochraceous; maculate with black as follows: Head with three small maculae on occiput; front with a minute oblique streak each side, and often with two maculae between eyes. Pronotum with four small, rounded maculae, two discal and two situated more anteriorly on sides. Elytra each with two broadly ovate maculae at base, the outer one slightly smaller, and at apical third with a very broad fascia, which is feebly bilobed, slightly narrowed toward suture; usual apical fascia lacking or obsolete, scarcely perceptible as a dull brownish margin on apex. Sternum heavily maculate an abdominal sternites all broadly banded

with black. Legs with apices of femora and tibiae, and tarsi entirely, black. Antennae blackish, first or first two segments pale. Palpi fuscous.

Head much broader than long, minutely, rather densely punctate, with a few scattered, coarse punctures, sides strongly convergent to eyes, which are as long as interocular width, inner portion not so wide as infraocular space. Pronotum very little longer than wide, sides subparallel at base, strongly constricted apically; disk with a feeble basal impression but without trace of a median impressed line. Elytra rather minutely, densely punctate, often rugosely so. Antennae elongate, distinctly attaining basal fourth of elytra, strongly tapering from third segment; scape reaching distinctly behind eye, slightly arcuate; second segment one-fifth as long as first, third a little more than half as long as first; remaining segments gradually shorter. Maxillary palpi in male very strongly transverse, securiform, much wider than labrum.

Length: 18-23 mm.

Type locality: Texas and New Mexico.

Distribution: Arizona, Texas, and Mexico.

Texan localities: 1; Big Bend Region. 1; Alpine [USNM]. 2; Presidio [USNM]. 2; Kingsville [CU]. Occurs from June to August; known to occur on greasewood flowers.

Remarks: This species is distinguished by the elytra having the postmedian fascia broad, and the apical fascia obsolete, the pronotum is only feebly longer than wide, and the head has the sides strongly convergent to eyes. But the elongate scape is the best distinguishing character of all; in this species of *Pyrota* alone does it extend behind the eye.

PYROTA PALPALIS Champion

Pyrota mylabrina Chevrolat. Horn, Trans. Am. Ent. Soc. 12:112, pl. 5, f. 13, 1885. Casey, Ann. N. Y. Acad. Sci. 6:173, 1891. *Pyrota terminata* LeConte. Champion, Biol. Centr.-Amer. Col. 4(2):16, 429, pl. 20, f. 1, 1892. *Pyrota palpalis* Champion, op. cit.:462, 1893. Denier, Rev. Soc. Ent. Arg. 6:64, 1934.

Bright ochraceous to dull orange or fulvous, elytra paler; with fuscous or black markings as follows: Head immaculate except on occiput. Pronotum with a rounded macula each side of middle on disk and another situated more anteriorly on side. Elytra each with three fasciae, one close to base, distinctly bilobed, rarely divided into two narrowly separated maculae; second fascia behind middle, usually with its anterior margin produced basad near middle, indented medially on hind margin, almost always broader than the pale interspaces; the third fascia apical, narrower than first two, emarginate anteriorly. Sternum strongly black maculate; abdomen with black bands on bases of first four sternites, each about as wide as the remaining pale spaces. Apices of femora and of tibiae, entire tarsi, palpi, and antennae (except scape), fuscous or blackish.

Upper surface finely and densely punctulate and obsoletely alutaceous, with numerous scattered, coarse punctures; elytra strongly alutaceous, especially on apical two-thirds, as well as rugulose. Head one-fifth wider than long, sides feebly converging to eyes, which are distinctly longer than interocular width, slightly broader than supraocular space. Pronotum one-fifth to one-third longer than wide, sides arcuate, narrowed on apical two-fifths. Metatibial spurs obliquely truncate and concave at apex, the inner one arcu-

ately so, slender, tapering, acute, the outer one more than twice as broad as the inner, regularly oval. Antennae reaching beyond elytral base, feebly tapering from sixth segment; scape reaching to or beyond middle of eye; second segment one-fourth and third three-fifths as long as first; remaining segments subequal in length to third, fourth segment often longer. Maxillary palpi in male strongly transverse, enlarged, about as wide as labrum.

Length: 12-16 mm.

Type locality: Villa Lerdo, Durango, Mexico.

Distribution: Mexico and Texas.

Texan localities: 7; College Station. 1; Taylor. 1; Marlin. 2; Bexar Co. 4; Brownwood [AMNH]. 4; Dallas [MU—1; USNM—3]. 2; Waco. 2; Corpus Christi [USNM]. 2; Victoria [USNM]. Occurs from April to October; on cotton.

Remarks: This species is distinguished by the form of the maxillary palpi in the male and by the form of the metatibial spurs.

Occasional specimens are more heavily maculated on the head and pronotum; the former may have the hind angles or entire vertex and sides, as well as two or four maculae on the front. On the pronotum the median maculae are sometimes enlarged and there may be two maculae on each side. Structural details are constant, however.

Pyrota perversa, new species

Pyrota terminata LeConte. Horn, Trans. Amer. Ent. Soc. 12:113, 1885. Casey, Ann. N. Y. Acad. Sci. 6:173, 1891.

Bright ochraceous to dull orange or fulvous, elytra paler; with fuscous or black markings as follows: Head often with occiput and hind angles maculate to a greater or lesser degree. Pronotum with two large, oval maculae, sometimes subvittiform, one each side of disk and a smaller one on side placed more anteriorly. Elytra with three fasciae, basal one bilobed but never divided, one behind middle with anterior border rounded, apical one nearly as broad as basal. Sternum maculate and abdominal sternites banded with black to a greater or lesser extent. Apices of femora, usually the entire tibiae, tarsi, palpi, and antennae blackish.

Otherwise as *mylabrina* except as follows: Sculpturing of upper surface a little smoother as a whole, elytra less strongly alutaceous. Metatibial spurs robust, slightly obliquely truncate, concave, the inner one oval, the outer one less than twice as broad, ovate, the mesal edge nearly straight. Antennae with second segment nearly one-third, and third two-thirds, as long as first; remaining segments subequal. Maxillary palpi in male scarcely enlarged, equal to about half the width of labrum.

Length: 13-18 mm.

Male *holotype*, female *allotype*, and 7 *paratypes;* College Station. 4 *paratypes;* topotypic. 1 *paratype;* Mission [USNM]. 6 *paratypes;* San Antonio [CU]. Occurs during September and October.

PYROTA ENGELMANNI LeConte

Pyrota engelmanni LeConte, Journ. Acad. Nat. Sci. Phila. (2) 1:91, 1848. Horn, Trans. Am. Ent. Soc. 12:113, pl. 5, fig. 14, 1885. Casey, Ann. N. Y. Acad. Sci. 6:173, 1891. *Lytta engelmanni* (LeConte). LeConte, Proc. Acad. Nat. Sci. Phila. 6:337, 1853. *Pyrota terminata* LeConte, Smiths. Misc. Coll. 167:159, 1866.

Bright ochraceous above, shining, elytra feebly so. Head black, except

front, which is ochraceous with a pair of round, black maculae between eyes. Pronotum with a round, black macula each side of middle of disk and two small maculae each side, the outer one small, just above coxa, the inner one larger, more anterior; hind angles sometimes blackish. Scutellum varying from yellow to black, in whole or part. Elytra each with two black maculae near base, the scutellar large, ovate, the humeral small, sometimes greatly reduced or wanting; a broad fascia occupying disk from basal two-fifths to apical fifth, not attaining side nor sutural margin; at apex a narrow lunule, attaining (or very minutely removed from) the apical margin. Rest of body black.

Entire upper surface minutely alutaceous and sparsely, minutely punctulate, the elytra more distinctly so; and with scattered, fine punctures, on elytra dense and slightly rugulose. Head one-half (male) or one-third (female) wider than long, sides arcuate, strongly convergent to eyes, especially in male; eye longer than interocular width, wider than infraocular and supraocular spaces. Pronotum about one-tenth longer than wide, straight basally, widened to near apical third, thence distinctly narrowed to apex, basal impression deep but small. Metatibial spurs with apices obliquely truncate, concave, the inner one narrowly so, acute, the outer one broadly ovate, about twice as broad as inner. Antennae attaining base of elytra, scarcely tapering apically; scape reaching to middle of eye, slightly arcuate; second one-fourth as long as first; third nearly twice as long as second; fourth slightly shorter than third; remaining segments subequal, a little shorter than fourth. Maxillary palpi in male strongly transverse, as broad as labrum.

Length: 13-18 mm.

Type locality: St. Louis, Mo. [*engelmanni*]; "Kansas, near the Rocky Mountains" [*terminata*].

Distribution: From Indiana and Mississippi to the Rocky Mountains.

Texan localities: 2; Alpine; [USNM]. Occurs in March on *Astragalus*.

Remarks: Distinguished by the broad elytral postmedian fascia, the dark legs and undersurface, and the form of the labial palpi in the male.

LeConte's original description of *terminata* applies equally to the specimens above described; none of the characters he employs to distinguish the two species are constant.

PYROTA TENUICOSTATIS Dugès

Lytta vittigera LeConte, Journ. Acad. Nat. Sci. Phila. (2) 4:22, 1858, [non Blanchard]. *Cantharis tenuicostatis* Dugès, La Naturaleza 4:160, pl. 2, f. 6, 1877. *Pyrota tenuicostata* Dugès, An. Mus. Michoacano 2:91, 1889. Champion, Biol. Centr.-Amer. Col. 4(2):pl. 20, f. 6, 1892. Denier, Rev. Soc. Ent. Arg. 6:67, 1934. *Pyrota dubitabilis* Horn, Trans. Am. Ent. Soc. 12:113, pl. 5, f. 16, 1885.

Dull ochraceous to red-orange and brown-red, more or less shining. Head with one large or two small maculae on front and sometimes a third; usually maculate on occiput. Pronotum with a rather large, black macula each side of middle of disk and two each side, which often coalesce with one another. Elytra each with a broad, black vitta extending from humerus to before apex, sinuous, widened at basal third, often fused with an elongate macula near scutellum, this macula is often absent or greatly reduced, or enlarged so as

to be nearly lost in the vitta. Sternum largely black; abdomen black except for entire fifth sternite and apices of the others. Legs (except bases of femora), antennae, palpi, and labrum, black.

Head one-fifth broader than long, minutely alutaceous and punctulate, with moderately coarse punctures interspersed, sides convergent to eye, which is distinctly longer than interocular distance, about as wide as infraocular area. Pronotum about one-third again as long as wide, sides nearly parallel on basal two-thirds, convergent anteriorly; disk minutely punctulate, with scattered coarse punctures, basal impression rather deep. Elytra minutely alutaceous and densely, finely punctate. Metatarsal spurs concave on inner side, inner spur slightly more than half as broad as outer, which has its apex elongate-ovate. Antennae reaching beyond elytral base, rather stout, feebly tapering apically; scape reaching to middle of eye, arcuate; second segment one-fourth as long as first; third segment one-half longer than second; remaining segments subequal to third. Maxillary palpi in male very strongly expanded on each side, broader than labrum.

Length: 18-19 mm.

Type locality: Near Rio Grande [*vittigera; dubitabilis*]; Almolonga, Mexico [*tenuicostatis*].

Distribution: Texas and Mexico.

Texan localities: 4; Weslaco. 17; Hidalgo Co. 3; Dimmit Co. 1; Eagle Pass. 8; Brownsville [USNM—5; MU—1]. 1; College Station. 1; Cameron Co. [USNM]. 1; Edinburg [AMNH]. 19; S.E. Hidalgo Co. [G. B. Vogt]. Occurs from May to September.

Remarks: Although very variable, this species is easily distinguished by the maculation of the pronotum and the elytra. The legs vary from nearly entirely black to mostly yellow.

It is not unlikely that this species and *divirgata* V & P of Mexico will prove to be identical. Champion separates the two on the basis of the surface of the elytra being "vaguely sulcate" (*tenuicostata*), or not sulcate (*divirgata*). In the material available for study this character is meaningless; unfortunately, no Mexican examples of typical *divirgata* are at hand for direct comparison. Undoubtedly, however, all published Texan records of the latter belong here.

PYROTA INSULATA (LeConte)

Lytta insulata LeConte, Journ. Acad. Nat. Sci. Phila. (2) 4:22, 1858. *Pyrota insulata* (LeConte). Horn, Trans. Amer. Ent. Soc. 6:114, pl. 5, f. 17, 1885. Champion, Biol. Centr.-Amer. Col. 4(2):434, pl. 21, f. 19, 1892. Denier, Rev. Soc. Ent. Arg. 6:62, 1934.

Dark brown to fuscous, rather shining. Head darker, with front largely ochraceous, except two small, dark maculae at middle. Pronotum ochraceous, with a large M-shaped dark marking on basal two-thirds of disk and two or three rounded, often coalescent maculae on side, the apical one subdiscal. Elytra subopaque, with extreme base, and narrow sutural and broad lateral margin, ochraceous; an arcuate, short vitta on basal third (widened and notched apically), and a small preapical macula, often joining with the suture, also ochraceous.

Head minutely alutaceous and rather densely and coarsely punctate, with

a few scattered, fine punctures, one-fourth broader than long, sides distinctly convergent to eyes; eyes prominent, much longer than interocular width, broader than infraocular and supraocular spaces. Pronotum about one-fourth longer than wide, sides nearly straight basally, gradually and feebly widened to apical two-fifths, thence arcuately constricted; disk minutely alutaceous, coarsely punctate basally, median sulcus sometimes visible basally, basal impression small but distinct. Elytra densely, finely alutaceous and densely, finely, rugosely punctate. Maxillary palpi with last segment in male greatly enlarged, expanded on both sides, securiform, about as large as labrum, in female unmodified. Metatibial spurs with apices obliquely truncate, concave, the inner one subacute, about half as wide as outer. Antennae robust, feebly tapering from the sixth segment; scape reaching to middle of eye, arcuate; second segment less than one-fourth as long, and third half as long, as first; remaining segments subequal in length.

Length: 11-24 mm.

Type locality: Texas.

Distribution: Arizona to Texas and Mexico.

Texan localities: 2; College Station. 7; Hidalgo Co. 3; Dimmit Co. 1; Bexar Co. 3; Donna. 3; Pearsall. 1; Presidio. 4; Pleasanton. 1; Taylor. 1; Waco. 1; Castolon. 2; Laredo. 1; Oakland. 2; Brownsville [USNM; MU]. 4; Dallas [USNM—1; MU—3]. 1; New Braunfels [USNM]. 1; San Diego [USNM]. 1; Llano [USNM]. 1; Laredo [USNM]. 1; Smith Co. [MU]. 1; Webb Co. [MU]. 1; Kingsville [CU]. Occurs from February to May and September (to December?); on cotton.

Remarks: Easily distinguished from the other members of the genus by its characteristic maculation.

PYROTA DISCOIDEA LeConte

Pyrota discoidea LeConte, Proc. Acad. Nat. Sci. Phila. 6:338, 1853. Horn, Trans. Am. Ent. Soc. 6:114, pl. 5, f. 20, 1885.

Ochraceous to ferruginous, shining. Head usually darker, sometimes with one or two blackish maculae on occiput. Pronotum with a small, rounded, black macula each side of middle, always well separated. Elytra paler than pronotum; together with three dark vittae, a common one along most of suture, and a sinuous one each side of disk from behind humerus to before apex, tapering at each end, especially basally; near scutellum an elongate, ovate macula. Body beneath largely black, apices of sternites often edged with yellowish; entire fifth sternite yellowish. Apices of femora and of tibiae, and entire tarsi, antennae, and palpi blackish.

Head rather densely, minutely and coarsely punctate, more than one-fifth wider than long, sides feebly divergent to eyes; eyes slightly longer than interocular width, distinctly broader than infraocular area. Pronotum varying from slightly longer to one-fourth longer than wide, sides broadly arcuate (or sometimes subparallel at base), narrowed apically; disk variable, more or less minutely punctate, with scattered, coarse punctures interspersed, basal impression deep, rounded. Elytra coarsely, irregularly, rugosely punctate. Metatibial spurs acute, inner one very slender, outer one robust, obliquely concavely truncate at apex. Antennae attaining basal fourth of elytra, thickened to eighth segment, thence feebly tapered to apex; scape short, not quite reaching middle of eye; second segment one-fourth length of first; third twice

as long as second; fourth and following segments subequal, shorter than third. Maxillary palpi unmodified in both sexes.

Length: 6.5-11 mm.
Type locality: Platte River.
Distribution: Kansas to Texas
Texan localities: 20; College Station. 1; Taylor. 1; Eagle Pass. 3; San Antonio [USNM]. 2; Dallas [USNM]. 2; Victoria [USNM]. 3; Lee Co. [MU]. Occurs from April to August; feeds on blooms of *Callirrhoe involucrata*.

PYROTA INVITA Horn

Pyrota invita Horn, Trans. Amer. Ent. Soc. 6:114, 1885.

Fuscous to black, feebly shining, sparsely pubescent. Head with front largely ochraceous. Pronotum ochraceous to ferrugineous, with an irregular macula each side of disk, freqeuntly coalescent and enlarged. Elytra stramineous or ochraceous, opaque; elytra together with three dark vittae, a common one on middle two-thirds of suture, and one on each disk extending from behind humerus nearly to apex, rather sinuous, broader apically and narrower at base; at base an oval macula near scutellum. Femora and tibiae sometimes pale basally.

Head one-fourth broader than long, minutely, densely, and coarsely, irregularly punctate, sides feebly divergent to eyes, which are large, broadly ovate, much longer than interocular width and much broader than infraocular area. Pronotum one-fourth longer than wide, sides broadly arcuate, narrower apically than at base; disk minutely, densely punctate and with several broad bands of coarse punctures, basal impression feeble. Elytra irregularly, rugosely, rather coarsely punctate. Metatibiae with spurs flattened on inner face, inner spur slender, outer one robust, the apex narrowly oval. Antennae reaching to apical fifth of elytra, rather stout, tapering apically; scape arcuate, in male reaching three-fourths, in female one-half across eye,; second segment one-fourth as long as first in male, one-third as long in female; third segment three times as long as second; remaining segments gradually shorter, except last which is elongate. Maxillary palpi unmodified in both sexes.

Length: 8-16 mm.
Type locality: near San Antonio, Texas.
Distribution: Texas.
Texan localities: 11; College Station. 4; Madison Co. 1; McLennan Co. 6; Dimmit Co. 1; Taylor. 1; Laredo. 1; Jim Wells Co. 1; Sabine [USNM]. 1; Clarendon [USNM]. 5; Cotulla [USNM]. 5; Forestburg [MU]. 1; Victoria [MU]. 2; Lee Co. [MU]. 2; Carrigo Springs, Dimmit Co. [AMNH]. Occurs from April to July; reported as occurring on "*Hedema*[?]" and *Monarda punctata*.

Remarks: This species greatly resembles *discoidea* but it is distinguished by the dark head, scutellum, legs, and lower surface of body. Furthermore, this species is unique in this genus in being finely and sparsely pubescent over the entire upper surface of the body.

P. limbalis LeConte (1866) is catalogued by Leng and others as a variety of the present species, despite the fact that *limbalis* has precedence by nearly twenty years. If anything, it is a variety of *discoidea*, as it is described as having the scutellum pale, not dark as in the present instance.

Pyrota lineata texana, new subspecies

Cantharis lineata Olivier, Ent. 4:14, pl. 2, f. 21, 1795. *Pyrota lineata* (Olivier). Horn, Trans. Amer. Ent. Soc. 12:115, pl. 5, f. 19, 1885.

Yellow to bright ochraceous, shining; head darker, immaculate; elytra paler, feebly shining. Pronotum with two small, rounded, brown maculae, one each side of middle. Elytra each with two dark brown vittae, sometimes obsolescent, one extending from base near scutellum, broader basally, the other behind humerus, attenuate at base, widest before middle, neither attaining apex, coalescent posteriorly. Sternum maculate with fuscous; abdominal sternites obsoletely bordered with brown. Apices of femora and tibiae, and entire tarsi, palpi, and antennae except scape sometimes, fuscous.

Head minutely alutaceous and coarsely punctate, one-fifth broader than long, sides slightly convergent to eyes; eyes about as long as interocular distance, as wide as infraocular space. Pronotum about one-fourth longer than wide, sides arcuate, strongly narrowed apically; disk minutely alutaceous and with scattered, rather coarse punctures, basal impression small, deep. Elytra rather coarsely, irregularly, rugosely punctate. Metatibial spurs flattened on inner faces, acute, the inner one slender, the outer one robust, its apex elongate-ovate, concave. Antennae feebly tapering from sixth segment, attaining basal fourth of elytra; scape reaching middle of eye, arcuate; second segment nearly one-third as long as first; third not quite twice as long as second; rest gradually shorter. Maxillary palpi unmodified in both sexes.

Length: 7-9 mm.

Holotype female and *allotype* male: College Station, Sept. 19, 1930.

Paratypes: 3; College Station, Sept. 6 and 27, 1931. 1; College Station, Oct. 7, 1928 [USNM]. 23; Smetana, Aug. 31, 1949 [author's collection].

Remarks: This subspecies differs from Alabama specimens in having the eltyral dark vittae narrow, scarcely broader than the yellow interspace. In addition, the head is minutely alutaceous, sometimes with minute punctures, while in the typical form the surface is never alutaceous.

PYROTA AKHURSTIANA Horn

Pyrota akhurstiana Horn, Trans. Am. Ent. Soc. 18:44, 1891. Champion, Biol. Centr.-Amer. Col. 4(2):434, pl. 21, f. 18, 1892. Denier, Rev. Soc. Ent. Arg. 6:3, 1934.

Black, shining, with rufo-testaceous markings as follows: Head with most of front and clypeus rufo-testaceous, the former marked with two large maculae between eyes and two small dots between antennae; clypeus with two small dots and lower margin black. Pronotum with an elongate triangular macula at middle of apex and a triangular macula each side, rufo-testaceous. Elytra with entire base, suture, and side and apical margins, rufo-testaceous.

Entire upper surface minutely, densely punctulate and with scattered, rather fine punctures; elytra somewhat coriaceous as well. Head one-ninth wider than long, sides arcuately feebly divergent to eyes, median sulcus indistinct; eyes equal to nearly twice interocular width, distinctly wider than infraocular and supraocular spaces. Pronotum one-fifth longer than wide, sides gradually widened to before middle, thence strongly narrowed to apex; disk with basal impression feeble. Metatibial spurs obliquely truncate at apex,

concave, the inner spur about two-fifths as broad as outer. Antennae attaining base of elytra, tapering from fifth segment; scape slightly surpassing middle of eye, arcuate; second segment one-fifth, and third three-fifths, as long as first, the latter arcuate, in male widened at base, boot-shaped; fourth slightly longer than, and remaining segments subequal to, third. Maxillary palpi in male greatly enlarged, transverse, much broader than labrum.

Length: 12-21 mm.
Type locality: New Mexico and Tucson, Ariz.
Distribution: Arizona, New Mexico, Texas, and Mexico.
Texan localities: 4; El Paso [USNM—2; MU—2]. Occurs in July and August; known to attack flowers of *Garita*.

Distinguished by the black, red-bordered elytra, the maculation of the prothorax, and by the form of the third antennal segment in the male.

Pyrota victoria, new species

Testaceous-yellow, shining; entirely immaculate except a pair of rounded, black spots at middle of pronotal disk. Femora and tibiae near apices feebly infuscate; tarsi brownish. Antennae (except pale scape) and palpi, fuscous.

Head one-fifth wider than long, sides arcuately, feebly converging to eyes, surface feebly alutaecous and minutely punctate, with scattered, coarse punctures interspersed; eye ovate, equal in length to interocular width, slightly wider than infraocular space. Pronotum one-third longer than wide, sides broadly arcuate, slightly narrower at apex than at base; disk indistinctly alutaceous and minutely punctulate, with a few coarse punctures, especially basally, basal impression rather deep, rounded, median line indicated by a series of punctures. Elytra densely alutaceous, coarsely, densely, rugosely punctate. Metatarsal spurs one-third as long as first tarsal segment, inner one very slender and acute, outer one broad, its apex strongly, obliquely truncate, the truncature occupying most of length of spur, broadly ovate, subacute apically. Antennae slightly surpassing elytral base, feebly tapering from sixth segment; scape slender, arcuate, reaching a trifle beyond middle of eye; second segment nearly one-fourth as long as first; third two-thirds as long as first; remaining segments subequal to third. Maxillary palpi in male scarcely enlarged, last segment about as long as half the width of labrum.

Length: 9 mm.
Holotype: Male; Victoria, Texas, September 19, 1909 on Croton, (J. D. Mitchell); [U. S. National Museum].

Remarks: Distinguished by the entirely pale elytra and by the peculiar form of the metatibial spurs from other members of the genus in the area. The immaculate head and undersurface and small size distinguish it from the Mexican species with unicolorous pale elytra.

Pyrota bilineata Horn

Pyrota bilineata Horn, Trans. Am. Ent. Soc. 12: 115, pl. 5, f. 22, 1885. Champion, Biol. Centr.-Amer. Col. 4(2): 435, 1892.

Yellowish-fulvous, shining; elytra much paler, often luteous. Pronotum with a small or obsolete, dark macula each side of middle of disk, sometimes absent. Elytra each with two distinct, sharply defined, black vittae, distinctly

narrower than the space between them, slightly sinuous. Metasternum largely black, except medially; abdominal sternites usually maculate with black. Apices of femora and of tibiae, entire tarsi, palpi largely, and antennae (except scape), fuscous.

Head and pronotum minutely, sparsely punctulate and with scattered, fine punctures; head one-sixth wider than long, sides arcuately convergent to eyes; eyes distinctly shorter than interocular width, not quite so broad as supraocular space. Pronotum about one-fourth longer than wide, sides straight basally, gradually widened to apical third, thence narrowed to apex; basal impression small but deep. Elytra either minutely alutaceous or punctulate, and densely, rather coarsely, rugulosely punctate. Metatibial spurs with apices strongly obliquely truncate, the inner one blunt, parallel-sided, the outer one four times as wide as inner, its apex rather broadly ovate, acute. Antennae slightly surpassing elytral base, feebly tapering from fifth segment; scape reaching to middle of eye, arcuate; second segment nearly one-third as long as first; third almost twice as long as second; remaining segments subequal to third. Maxillary palpi in male unmodified.

Length: 7-9 mm.

Type locality: Colorado and Arizona.

Distribution: Colorado, Arizona, Texas, and Mexico.

Texan localities: 2; Ysleta, El Paso Co.; [USNM]. 1; Van Horn; [MU]. Occurs in September.

Remarks: It is not impossible that this will eventually prove to be a subspecies of *lineata*, as structurally the two forms are almost identical; until more material becomes available, the question cannot be finally decided.

The sharply defined, narrow elytral vittae, and the dark metasternum are the principal distinguishing characteristics.

PYROTA MYLABRINA Chevrolat

Pyrota mylabrina Chevrolat, Col. Mex. I(53):1834. Dugès, An. Mus. Michoacano 2:95, 1889. Champion, Biol. Centr.-Amer. Col. 4(2):430, pl. 20, f. 3, 1892. Denier, Rev. Soc. Ent. Arg. 6: 63, 1934.

Bright ochraceous to orange-fulvous, shining; elytra not or scarcely paler; with dark markings as follows: Head immaculate, except on sides of occiput. Pronotum with four maculae, two discal and one on each side placed more anteriorly. Elytra each with two basal maculae, well separated, the scutellar one broader and larger than the outer, and with two fasciae, one behind middle, narrower than pale interspaces, usually feebly narrowed toward suture; and a rather narrow, lunate one on apex. Sternum rather heavily maculate with black and the five abdominal sternites rather broadly black-banded. Femora and tibiae at apices, entire tarsi, palpi, and antennae (except scape in part), black or fuscous.

Exactly as in *P. palpalis* except as follows: Eye never longer than interocular width, usually distinctly shorter, as narrow as infraocular space and distinctly narrower than supraocular area. Metatibial spurs short, robust, the apices obliquely truncate, that of the inner one more strongly so, narrowly ovate, nearly half as broad as the outer which is broadly and regularly ovate. Antennae scarcely attaining elytral base in female, slightly longer in male,

only very slightly tapering apically; in male scape reaching nearly across eye, in female to beyond middle of eye; second segment one-fourth and third three-fifths as long as first; in male fourth and fifth segments subequal to third, following gradually shorter, in female fourth and following much shorter than third. Maxillary palpi in male a little broader than in *palpalis* but not so broad as in *concinna*.

Length: 13-17 mm.
Type locality: Tuxpan, Mexico.
Distribution: Arizona to Texas and Mexico.
Texan localities: 1; Laredo. 2; Dimmit Co. 2; Edinburg [MU; AMNH]. 1; Hidalgo [USNM]. 1; Kingsville [CU]. Occurs from March to June; one specimen eating leaf of bean.

Remarks: Most easily distinguished from the more common *palpalis* by the smaller eye. Moreover, the median fascia of the elytra in the present species is narrower than the pale spaces between it and the other dark markings, whereas in *palpalis* it is almost always much broader. In the female, the outer antennal segments are strongly abbreviated.

TRIBE MELOINI

Body robust, irregular in form, convex. Head always broader than pronotum, rather strongly depressed, not thick between front and ventral surface; sides slightly arcuate; vertex broad, distinct from sides; front with median sulcus absent or confined to upper half; eyes always narrower than interocular width, arcuate, suberect below, lower margin nearly straight, more or less uniformly adjacent to mandibular margin of head. Pronotum widened anteriorly; disk subplanate, not depressed anteriorly nor tumid basally, median sulcus obsolete or wanting. Elytra punctate, strigose, or with reticular elevated lines; hind wings absent. Metasternum very short. Legs rather short, successive pairs from the front to rear increasingly longer; metafemora not attaining apex of abdomen; tibiae often arcuate; metacoxae elongate, longer than mesocoxae; tarsal claws cleft, with lower portion largely membranous (*Meloë*), or not cleft, with a distinct subbasal tooth. Antennae moderate in length, attaining base of pronotum.

KEY TO TEXAN GENERA

1. Tarsal claws cleft to base, lower portion nearly as long as upper, mostly membranous ..... *Meloë*
   Tarsal claws not cleft, dentate near base 2
2. Elytra long, exposing only a small portion of abdomen, subspherical, connate along suture ..... *Cysteodemus*
   Elytra short, divergent, exposing most of abdomen, not connate along suture .... *Megetra*

CYSTEODEMUS LeConte

Cysteodemus LeConte, Ann. Lyc. Nat. Hist. N. Y. 5:158, 1851; Proc. Acad. Nat. Sci. Phila. 6:329, 1853. Lacordaire, Gen. Col. 5:661, 1859. Van Dyke, Univ. Cal. Publ. Ent. 4:458, pl. 17, figs. 11, 12, 1928.

Small or moderate-sized, robust; surface reflexed with bright metallic green or purple. Head very little wider than long, median line not impressed or but feebly so; eyes small, lunate; clypeus on same plane as front, relatively elongate; labrum slightly emarginate at apex. Pronotum strongly transverse;

sides at least with a small tubercle before middle; disk obliquely depressed posteriorly, with an entire median impressed line. Scutellum scarcely perceptible. Elytra greatly tumid, globose, connate along suture; surface coarsely punctate, leaving reticular elevated interspaces; wingless. Legs rather long (metafemora reaching beyond apex of abdomen), subequal, the front pair slightly shorter; tibiae feebly arcuate, protibiae not densely pubescent on inner side; all tibial spurs slender, spiniform; tarsal claws not cleft, with a very short tooth at base. Sternal side-pieces concealed by the reflexed portion of elytra; metasternum very short, the metacoxae partially overlapped by the mesocoxae. Antennae short, attaining pronotal base, segments cylindrical; scape very short, scarcely reaching one-fourth across eye; the second segment half as long as, and the third and fourth segments longer than, first.

Genotype: Cysteodemus armatus LeConte.

CYSTEODEMUS WISLIZENI LeConte

Cysteodemus wislizeni LeConte, Ann. Lyc. Nat. Hist. N. Y. 5:158, 1851; Proc. Acad. Nat. Sci. Phila. 6:330, 1853. Champion, Biol. Centr.-Amer. Col. 4(2):369, pl. 17, f. 10, 1892. Van Dyke, Univ. Cal. Publ. Ent. 4:460, 1928.

Fuscous to black, brilliantly reflexed with metallic green or purple.

Upper surface densely, minutely alutaceous (pronotum obsoletely so) and with sparse, coarse punctures; elytra very coarsely punctate, the interspaces forming reticular elevated lines. Head one-tenth wider than long, sides broadly rounded to eyes, median impressed line distinct to middle of front; eyes lunate, scarcely longer than half of interocular width, about two-thirds as broad as infraocular space. Pronotum three-fifths as long as wide, sides widened to apical two-fifths, thence rectilinearly narrowed to apex, at angle of sides a blunt tubercle placed somewhat toward disk; disk obliquely depressed basally, median impressed line entire, deeper apically. Protibiae with two slender spurs in both sexes; metatibial spurs spiniform, acute. Protarsi with pads on the soles in male, unpadded in female. Antennae slender, attaining base of pronotum; scape reaching one-fourth across eye; second segment half as long as first; third and fourth subequal, one-fourth longer than first; remaining segments about equal in length to first.

Length: 9-16 mm.

Type locality: New Mexico.

Distribution: New Mexico and Arizona to northern Mexico.

Texan localities: 5; Castolon. 3; Balmorhea. 3; Presidio. Occurs from May to September.

MEGETRA LeConte

Megetra LeConte, in Thomson, Arc. Nat.:127, 1859. Dugès, Bull. Soc. Zool. France:580, 1886. Van Dyke, Univ. Cal. Publ. Ent. 4:453, pl. 16, fig. 9, 1928.

Rather large, robust, black beetles; elytra with orange vittiform maculation. Abdomen very large in proportion to head and thorax. Head distinctly broader than long, sides feebly arcuate, median impressed line wanting or obsolete; eyes rather small, ovate, oblique; clypeus rather broad, on same plane as front; labrum slightly broader than clypeus, feebly emarginate at apex. Pronotum strongly transverse, feebly narrower than head, sides widest before middle, strongly narrowed to base and apex; apical and basal margins deeply

emarginate. Elytra strongly abbreviated, at most reaching to apex of second visible tergite, not meeting along suture but strongly divergent, lateral reflexed portion covering sternal side-pieces. Metasternum very short, the mesocoxae overlapping the metacoxae. Tibiae all with two simple spurs, protibiae with a dense mat of dark pubescence on entire inner edge; tarsal claws acutely dentate at base, the tooth about one-third as long as claw. Antennae rather short, reaching base of elytra, feebly thickened apically; scape very short, extending about one-fifth across eye; third segment longest; all segments subcylindrical.

KEY TO TEXAN SPECIES

Elytral maculation consisting of broad series of irregularly reticulating orange lines extending nearly to apex ..... *cancellata championi*

Elytral maculation consisting of a single nearly straight elevated line from which radiate short diverticula, reaching only to apical third of elytra ..... *vittata*

MEGETRA VITTATA (LeConte)

Cysteodemus vittatus LeConte, Proc. Acad. Nat. Sci. Phila. 6:330, 1853. *Megetra vittata* (LeConte). LeConte, in Thomson Arc. Nat. 1:127, 1859. Champion, Biol. Centr.-Amer. Col. 4(2): 370, 1892. Van Dyke, Univ. Cal. Publ. Ent. 4:456, pl. 17, f. 9, 1928.

Piceous or black; head above fuscous or reddish, usually indistinctly so. Elytra with a straight orange vitta near declivity, attaining apical third, with a few diverticula of orange emanating from it but narrow as a whole. Abdominal segments apically edged with orange or reddish, sometimes obscurely so.

Upper surface minutely, densely alutaceous, with scattered fine punctures; elytra rugulose and coarsely punctate, with elevated lines only toward side of disk, almost all of which are pale. Head one-third wider than long, sides feebly arcuate, median impressed line wanting; eyes little more than half as long as interocular width, rather broadly ovate, as wide as infraocular space. Pronotum nearly twice as wide as long, feebly narrower than head; sides strongly widened to before middle, thence narrowed to apex, somewhat sinuate near base; disk with a faint indication of the median line, variably impressed. Protibiae with anterior spur and metatibiae with outer spur, arcuate; all spurs slender, spiniform. Antennae reaching middle of pronotum, somewhat more robust apically; scape reaching about one-fifth across eye; second segment half as long as first; third three times as long as second, fourth one-sixth shorter than third; remaining segments gradually shorter.

Length: 14-21 mm.

Type locality: New Mexico.

Distribution: New Mexico and Arizona to northern Mexico.

Texan localities: 3; Ft. Davis [MU—2]. 2; Alpine [MU]. 1; Frijole, Culbertson [MU]. Occurs in July and August.

MEGETRA CANCELLATA CHAMPIONI Van Dyke

Meloë cancellatus Brandt and Erichson, Nov. Act. Leopold-Car. 16:141, pl. 8, f. 9, 1831. *Megetra cancellata* (Brandt and Erichson). LeConte, Ann. Mag. Nat. Hist. (4), 6:404, 1873. Dugès, An. Mus. Michoacano 2:38, 1889. Champion, Biol. Centr.-Amer. Col. 4(2):370, 1892. *Megetra cancellata championi* Van Dyke, Univ. Cal. Publ. Ent. 4:456, 1928.

Black; glabrous. Head with a rather narrow area across vertex of bright

red. Elytra with a broad, elongate area of reticulating elevated orange-yellow lines nearly reaching apex. Abdominal segments above and below with apices narrowly margined with orange-yellow.

Upper surface densely, minutely alutaceous and very sparsely, finely punctate; elytra rugulose and with a series of poorly defined, reticulating, raised lines, which are in great part pale-colored. Head one-fourth wider than long, sides arcuately divergent to eyes, median sulcus feebly indicated on lower half of front; eyes narrowly ovate, about two-thirds as long as interocular width, oblique, about as broad as infraocular space. Pronotum strongly transverse, three-fifths as long as wide, slightly narrower than head, sides strongly widened to before middle, thence still more strongly narrowed to apex; disk feebly tumid laterally, with a broad shallow depression medially before base. Protibiae with anterior spur slightly shorter but stouter than hind one; metatibiae with outer spur a little shorter and stouter than inner. Antennal scape reaching about one-fifth across eye; second segment half as long as first; third slightly longer than first; fourth feebly shorter than third; remaining segments gradually shorter.

Length: 16-23 mm.

Type locality: Mexico.

Distribution: From Mexico into New Mexico and Arizona.

Texan localities: 9; Madera Springs. 4; Pecos. 4; Van Horn, Culbertson Co. [MU]. Occurs from September to November.

Remarks: The Texan and Arizonan form differs from the southern Mexican type in having the red reticular area reduced, not covering the entire elytron.

MELOË Linné

Meloë Linné, Syst. Nat. Ed. 10:419, 1758. LeConte, Proc. Acad. Nat. Sci. Phila. 6:328, 1853; Smiths. Misc. Coll. 11:269, 1873. Champion, Biol. Centr.-Amer. Col. 4(2):364, 1892. Wellman, Can. Ent. 44:395, 1910. Van Dyke, Univ. Cal. Publ. Ent. 4:417, 1928.

Moderate-sized, black or black-violet beetles, very irregular in outline. Head broader than prothorax, much broader than long, median impressed line usually wanting; eye small, not prominent, oblique, somewhat arcuate. Prothorax subplanate, sides widened from base to apical third or fourth, thence narrowed to apex, which is somewhat narrower than the emarginate base. Scutellum small. Elytra abbreviated, divergent apically, imbricate along suture; hind wings wanting. Legs rather short; tibiae (except metatibiae) arcuate, tibial spurs spiniform, rather long, the outer metatibial spur and sometimes the inner, expanded and concave at apex; tarsi feebly longer than tibiae, tarsal claws cleft, the lower portion membranous, usually as long as upper part. Antennae usually reaching slightly behind elytral base, filiform or clavate, variable in the several species.

Genotype: Meloë majalis Linné, designated by Wellman.

KEY TO TEXAN SPECIES

1. Fifth to seventh antennal segments stouter than following in female, strongly dilated and contorted or flattened in male 2
   Fifth to seventh antennal segments not so stout as following in females, at most feebly enlarged in male ..... *laevis*

2. Eye in length subequal to about half the interocular width, not prominent 3
Eye in length distinctly exceeding half the interocular width, equal to about three-fifths its width, strongly prominent .....*texanus*
3. Pronotum rather finely, densely punctate throughout, very densely and finely so at apical margin .....*kirbyi*
Pronotum quite sparsely, finely punctate, the punctures not any denser or finer along apical margin .....*paropacus*

Meloe texanus new species

Meloë americanus Leach. Van Dyke, Pan-Pac. Ent. 6:122, 1930 [ex parte]. *Meloë moerens* LeConte. Van Dyke, Univ. Cal. Publ. Ent. 4:423, pl. 18, fig. 15 [ex parte].

Black, subopaque, sometimes with a scarcely visible violaceous reflex.

Head and pronotum densely, minutely alutaceous, with numerous, fine punctures rather widely spaced, sparser on pronotum, especially on middle of basal half. Head about one-third wider than long, sides slightly divergent (or very feebly convergent) to eyes; eyes prominent, ovate, in length equal to three-fifths the interocular width, strongly oblique. Pronotum as long as wide or a little longer, distinctly narrower than head; sides widest at apical third, posteriorly sinuate, anteriorly arcuate; disk with impressions variable in form and position, frequently absent. Elytra alutaceous and finely, densely rugulose, with scattered, indistinct punctures. Inner spurs of all tibiae slender and arcuate, the outer spur of metatibiae nearly three times as broad as inner. Antennae reaching nearly to middle of elytra, rather robust; scape extending two-fifths across eye, robust, arcuate; second segment half as long as first; third one-fifth longer than first and fourth subequal to first; fifth in male somewhat expanded but not compressed, slightly shorter than fourth, sixth and seventh strongly compressed, the former lamelliform, each subequal to fourth in length; eighth and ninth feebly shorter than fourth, tenth and eleventh successively distinctly longer; in female fifth and following not expanded, subequal to fourth.

Length: 14-18 mm.

Holotype: Male; College Station, Texas, Dec. 13, 1937.

Allotype: Female; Victoria, Texas, Jan. 17, 1907; [U. S. Nat'l. Mus.].

Paratypes: Male, 2 females; Dallas, Texas, Feb. 17, 1908 [U. S. National Museum].

Remarks: By its large eye this form may be distinguished from all known Texan *Meloë*. The sculpturing of the upper surface and the antennal structure are other diagnostic characters.

From *M. americanus* Leach, to which it is most closely related, this form differs in the much coarser punctation and in the eighth and ninth antennal segments being scarcely longer than wide. From *M. strigulosus* Mannerheim, it is distinguished by the feeble strigulations of the elytra.

One male from Dallas in the U. S. National Museum had been doubtfully determined as "*M. moerens*" by Van Dyke.

Meloe kirbyi, new name

Meloë impressa var. *nigra* Kirby, in Richardson, Fauna Bor-Am. 4:243, 1837. [non DeGeer, 1775]. *Meloë impressus* Kirby. Van Dyke, Univ. Cal. Publ. Ent. 4:435, pl. 19, fig. 22, 1928. *Meloë niger* Kirby. Van Dyke, Pan-Pac. Ent. 6:122, 1930.

Black, subopaque, with a dull greenish metallic lustre; elytra a little more shining.

Head and pronotum densely, minutely alutaceous, covered rather uniformly and densely with fine punctures, sparser on lower part of front and base of pronotum, very dense at apex of pronotum. Head nearly one-half wider than long, sides converging to eyes; eyes oblique, ovate, quite small, in length not quite equal to half of interocular width. Pronotum distinctly broader than long, nearly as wide as head; sides subparallel on basal half, bulbous on anterior half. Elytra minutely alutaceous, rather smoothly rugulose or coriaceous. Inner tibial spurs slender, arcuate, outer metatibial spur comparatively narrow, about twice as broad as inner. Antennae (male) attaining basal fourth of elytra, segments loosely arranged; scape reaching one-third across eye, feebly arcuate; second segment half as long as first; third one-fifth longer than first; fourth slightly shorter than first; fifth, sixth, and seventh strongly expanded, the last two strongly compressed, the fifth only slightly so, as long as third segment; sixth and seventh somewhat shorter than fourth; remaining segments much shorter, except eleventh, which is elongate.

Length: 23 mm.
Type locality: East Canada.
Distribution: East Canada and Middle Atlantic States, west to Iowa and Wyoming.
Texan locality: 1 male; New Braunfels, May, 1902 [USNM].

Remarks: This species is the most densely and coarsely punctate *Meloë* found in Texas; the small eye and the antennal structure are further distinguishing characteristics.

Without material from Canada for comparison, this form could not be distinguished from *niger;* eventually, it may prove to be, however, a distinct form.

Meloe paropacus, new species

Black, feebly shining; antennae with a distinct metallic blue reflex.

Entire surface densely, minutely alutaceous; head and pronotum finely punctate, the punctures irregularly placed, rather dense on vertex and toward base and apex of pronotum, especially laterally; elytra coriaceous, obsoletely rather finely punctate; abdomen above as elytra, beneath densely, finely distinctly punctate. Head one-fourth wider than long, sides straight, somewhat convergent to eyes, with a feeble median line on lower portion of front; eye not prominent, small, in length equal to scarcely more than half the interocular width, distinctly narrower than infraocular space. Pronotum as wide as long, distinctly narrower than head, sides feebly arcuate, rather strongly widened to apical third, thence suddenly constricted to apex; disk without trace of median impressed line. Metatibiae with outer spur concave and truncate apically, much broader than the spiniform inner one. Antennae (female) filiform, loosely segmented, thickest medially, tapering feebly to both ends, extending to basal fourth of elytra; scape reaching two-fifths across eye, nearly straight; second segment less than half as long as first; third not quite so long as first; fourth feebly shorter than third; fifth, sixth, and seventh each subequal to fourth, the sixth the thickest segment of all; eighth and ninth scarcely longer than second; tenth and eleventh successively longer.

Length: 12 mm.
Holotype: Female; Eagle Pass, Jan. 29, 1933.

Remarks: The following combination of characters will serve to distinguish this form: Antennae distinctly metallic blue, the third segment slightly shorter than first; punctation of head and pronotum fine, irregularly dense, that of elytra obsolete and fine; abdomen above largely nearly impunctate, beneath densely, finely, and distinctly punctate; pronotum subquadrate, sides slightly arcuate; head with sides straight, convergent to eyes; and pronotum subquadrate with sides arcuate, not at all sinuate.

This species is apparently closely related to *M. opacus* LeConte, but is distinct in the elytra being punctate, the entire body surface at least feebly shining, and the punctation of head and pronotum sparser and finer.

MELOË LAEVIS Leach

Meloë laevis Leach, Trans. Linn. Soc. Lond. 11:249, pl. 18, f. 4, 1815. Champion. Biol. Centr.-Amer. Col. 4(2): 366, pl. 17, f. 3, 1892. Van Dyke, Univ. Cal. Publ. Ent. 4:445, 1928. *Meloë sublaevis* LeConte, Proc. Acad. Nat. Sci. Phila. 7:84, 1854.

Black, feebly shining, sometimes with a feeble, deep blue reflex.

Entire upper surface very densely, minutely alutaceous, and minutely (but distinctly), sparsely punctate; elytra not punctate, scarcely rugulose, nearly smooth; abdomen above and below likewise alutaceous and very sparsely, minutely punctate. Head one-third to one-half wider than long, sides strongly arcuate so that outline of head is subglobose, without trace of median impressed line; eye oblique, small, scarcely prominent, in length slightly exceeding half the interocular width, narrower than infraocular space. Pronotum feebly wider than long, distinctly narrower than head, sides straight, strongly divergent to apical fourth, thence arcuately narrowed to apex; disk with a distinct smooth median line on basal half which is not visibly impressed. Metatibial spurs concave and truncate apically, the outer one longer and about twice as broad as inner, which is arcuate. Antennae (female) clavate, segments rather compactly arranged, scarcely attaining base of elytra; scape arcuate, short, reaching one-fourth across eye; second segment half as long as first; third segment one-half longer than second; fourth nearly as long as first; fifth as long as third; sixth subequal to fourth, seventh slightly shorter, the remaining segments gradually increasing in length.
[MU].

Length: 21-30 mm.
Type locality: San Domingo [*laevis*]; Fort Union, New Mexico [*sublaevis*].
Distribution: Costa Rica to Arizona, Colorado, and west Texas.
Texan localities: 2; Cochise Co., July, 1930 [MU]. 1; Fort Davis, Aug. 13, 1914
Remarks: This species may be recognized by the subglobose head, the nearly impunctate upper surface, the similarly nearly impunctate lower surface of abdomen, the comparatively smooth and impunctate elytra, and by the antennal formula.

Tegroderini, new tribe

Body usually elongate, convex. Head always broader than pronotum, rather thick between front and ventral surface, sides rounded; front with a

median sulcus; eyes rather small, often erect or nearly so, usually not emarginate. Pronotum declivous and depressed anteriorly, strongly tumid posteriorly, with a pronounced median sulcus. Elytra with costae, elevated lines, or impressed maculae. Legs rather elongate, successive pairs longer posteriorly, metafemora approaching or surpassing apex of elytra; tibiae often arcuate; tarsal claws usually not cleft but with a rather long tooth at base. Antennae short, not attaining base of pronotum; scape not reaching more than one-third across eye

The members of this tribe are closely related to those of the tribe Lyttini, with which they have been previously placed. However, they are constantly distinct in the form of the pronotum and the successively longer legs. The thickened head, the form of the eyes, the dentate tarsal claws, and the very short antennae are further points of distinction.

Phodaga LeConte from California also belongs here.

KEY TO TEXAN GENERA

1. Elytra with four or five strongly elevated costae, interconnecting at apex and at apical third ..... *Pleuropasta*
   Elytra with many reticular lines or impressed maculae 2
2. Eyes erect; elytra with impressed maculae ..... *Negalius*
   Eyes oblique or arcuate; elytra with elevated reticular lines 3
3. Eyes regularly arcuate; front in male with a deep impression each side ..... *Tegrodera*
   Eyes subovate; front in male with a deep median impression ..... *Eupompha*

TEGRODERA LeConte

Tegrodera LeConte, Ann. Lyc. Nat. Hist. N. Y. 5:159, 1851. Blaisdell, Can. Ent. 50:133, 1918. *Lytta* Fabricius. LeConte, Proc. Acad. Nat. Sci. Phila. 6:330, 1853 [ex parte].

Large beetles, compressed, elongate; feebly villose beneath, glabrous above. Labrum subtruncate, not or feebly emarginate; front deeply bisulcate below; eye produced under antennal insertion. Pronotum subquadrate, depressed on anterior portion, sides of disk strongly tumid. Elytra covered with a network of coarse elevated lines. Legs elongate, especially hind ones; tarsi with the lower division of the claw shorter than the upper. Antennae shorter than prothorax, rather robust, cylindrical, slightly attenuate apically, segments from second short, fourth to tenth equal, eleventh terminating in a conical process.

Genotype: Tegrodera erosa LeConte, by monotypy.

TEGRODERA EROSA LeConte

Tegrodera erosa LeConte, Ann. Lyc. Nat. Hist. N. Y. 5:159, 1851. Lacordaire, Gen. Col. 5:675, 1859. Blaisdell, Can. Ent. 50: 333. 1918. *Lytta erosa* (LeConte). LeConte, Proc. Acad. Nat. Sci. Phila. 6:342, 1853.

Black; head, most of pronotum except the dark apex, and tibiae in great part, brown-red. Elytra with numerous, coarse, reticulating, yellow, elevated lines; the suture, lateral margins, and a band before middle, entirely fuscous.

Body above minutely alutaceous; head, pronotum, and scutellum with scattered, coarse punctures; elytra with elevated lines as described above. Head distinctly wider than long, sides diverging to below eyes; front with an oblique, deep canal each side below eye and a deep impression medially on

upper portion; eye oblique, semilunar, partially extending beneath antennal insertion, about two-thirds as long as interocular space. Pronotum not quite so long as broad, nor quite so broad as head; disk strongly irregular, depressed broadly across apex, basal two-thirds tumid, with several irregular impressions, including a deeper median basal one. Sixth sternite deeply emarginate in male. Legs and antennae wanting in the single example at hand.

Length: 22 mm.
Type locality: San Diego, California.
Distribution: Southern and Lower California to west Texas.
Texan localities: 1; Shovel Mt., Burnett Co. [USNM].

EUPOMPHA LeConte

Eupompha LeConte, Journ. Acad. Nat. Sci. Phila. (2) 4:21, 1858; Smiths. Misc. Coll. (136):274, 1862.

Moderate-sized, elongate-oblong, rather slender; bright metallic green, hirsute below, glabrous above. Head distinctly broader than long in female, feebly so in male, sides rounded to eyes; front deeply sulcate in female, extremely so in male; vertex elevated in male; eye oblique, ovate, not emarginate, moderately large; labrum truncate at apex. Pronotum as long as broad, narrower than head, sides expanded to before middle; disk depressed on apical third, basal two-thirds strongly tumid. Scutellum very short, scarcely reaching vertical portion of elytral base. Elytra covered with reticular elevated lines. Protibiae sinuate in male; metatibiae with outer spur robust, inner one spiniform. Antennae rather short, tapering apically, the segments cylindrical; scape not reaching beyond middle of eye; second segment short; the third slightly shorter than first.

Genotype: Eupompha fissiceps LeConte, by monotypy.

EUPOMPHA FISSICEPS LeConte

Eupompha fissiceps LeConte, Journ. Acad. Nat. Sci. Phila. (2) 4:21, 1858; Smiths. Misc. Coll. (136): 274, 1862.

Brilliant metallic green; head, legs, and basal segments of antennae rufous; femora at base and antennae apically blackish.

Upper surface densely, minutely punctulate and coarsely, sparsely punctate; pronotum densely punctate; elytra covered with a network of elevated lines. Head somewhat broader than long, very feebly so in male; sides slightly converging to eyes, median sulcus broad and deep, canaliculate, extremely deep in male; eyes oblique, ovate, about two-thirds as long as interocular width, nearly or quite equal to it in male, about three-fourths as broad as supraocular space. Pronotum as wide as long, one-fifth narrower than head, sides straight, divergent to apical two-fifths, thence strongly constricted to apex; disk depressed anteriorly, basal two-thirds strongly tumid, with a large, deep fovea each side of middle and a deep median sulcus, basal impression terminal, deep. Protibiae bisinuate apically in male, with a pair of subequal spurs in both sexes; metatibiae with inner spur spiniform, slender, outer one rather robust, truncate apically, truncature ovate. Protarsi with first three segments greatly enlarged in male. Antennae short, attaining basal fifth of prothorax, segments cylindrical; scape not quite reaching middle

of eye; second segment one-third and third two-thirds, as long as first; fourth and following three-fourths as long as third, subequal; in female the third segment is sometimes scarcely longer than fourth.

Length: 18-20 mm.
Type locality: New Mexico.
Distribution: New Mexico and Texas.
Texan localities: 3; Presidio. 1; Castolon. Occurs from June to September.

PLEUROPASTA Wellman

Calospasta LeConte, Smiths. Misc. Coll. (136):273, 1862. Horn, Trans. Amer. Ent. Soc. 3:92, 1870; Proc. Amer. Phil. Soc. 29:99, 1891. Champion, Biol. Centr.-Amer. Col. 4(2):394, 1892. [ex parte]. *Pleuropasta* Wellman, Ent. News 20: 20, 1909. *Pleurospasta* auct.

Small, cylindrical, rather slender. Head wider than long, sides subparallel to eyes; front with an indistinct median impressed line; eyes small, broadly oval, not emarginate, oblique; clypeus and labrum distinct, transverse; antennal insertion directly before base of clypeus. Pronotum feebly wider than long, narrower than head, basally tumid, anteriorly constricted and depressed. Elytra with several longitudinal elevated lines, becoming more or less reticular before apex. Legs rather long, metafemora reaching beyond tip of abdomen; protibiae with a narrow strip of silky pubescence on inner surface, tibial spurs spiniform, slender; tarsal claws not cleft, with a prominent basal tooth. Antennae lacking in only specimen at hand.

Genotype: Calospasta mirabilis Horn, by monotypy.

PLEUROPASTA MIRABILIS (Horn)

Calospasta mirabilis Horn, Trans. Am. Ent. Soc. 3:93, 1870. Proc. Am. Phil. Soc. 29:99, 1891. Champion, Biol. Centr.-Amer. Col. 4(2):394, pl. 17, f. 12, 1892. *Pleuropasta mirabilis* (Horn). Wellman, Ent. News 20:20, 1909.

Nearly entirely dull testaceous, glabrous; elytra creamy-white, with an irregular fascia at apical third, broadened toward suture, and a narrower one on apex, bright fulvous, both bands irregularly flecked with black; a black dot on basal one-eighth, placed somewhat toward suture.

Head rather sparsely, coarsely punctate, broader than long, sides feebly divergent to eyes; eyes ovate, prominent, oblique, greatest length not much more than half the interocular width. Pronotum feebly wider than long, tumid on basal two-thirds, constricted apically both on disk and laterally; disk finely, irregularly rugulose, with a deep median sulcus extending from near apex to base. Elytra each with four prominent, longitudinal carinae, interconnected apically by several transverse carinae. Tibial spurs all long, spiniform, slender. Antennae defective in the single example studied; scape arcuate, short, reaching about one-third across eye; second segment distinctly shorter than first; remaining segments wanting.

Length: 7.3 mm.
Type locality: Southern Arizona.
Distribution: Southern California to west Texas and northern Mexico.
Texan localities: 1; Eagle Pass, April 26, 1919 [USNM].

NEGALIUS Casey

Negalius Casey, Ann. N. Y. Acad. Sci. 6:175, 1891.

Moderate-sized, convex, ovate species. Head strongly transverse, sides

rounded to mandibles, vertex arcuate; front with a short median impressed line; eyes small, erect, subovate, not emarginate; clypeus and labrum distinct; antennal insertion directly above base of clypeus. Pronotum distinctly transverse, narrower than head, basally tumid, anteriorly constricted and depressed. Elytra with irregular impressed maculae. Legs rather long, slender; metafemora almost attaining apex of abdomen; tibiae arcuate, tibial spurs spiniform, slender, greatly elongate in part in male; tarsal claws not cleft, with an acute basal tooth. Antennae short, not reaching base of pronotum, segments slightly widened from fourth.

Genotype: Negalius marmoratus Casey, by monotypy.

NEGALIUS MARMORATUS Casey

Negalius marmoratus Casey, Ann. N. Y. Acad. Sci. 6:175, 1891.

Black; elytra rather densely marbled with irregular, impressed, whitish maculae.

Entire upper surface minutely alutaceous. Head with sides rounded to mandibles; front convex, with a median sulcus on lower half; eye vertical, ovate, truncate below, height equal to about two-thirds interocular width. Pronotum one-third wider than long, distinctly narrower than head, sides widened to before middle, thence arcuate and strongly constricted to apex, basal margin distinctly emarginate; disk with a fine median impressed line. Elytra each with three feeble costae, finely interconnecting apically. Protibiae in male with inner spur minute, outer one short, straight, acute; mesotibiae in male with spurs slender, acicular, the inner one greatly elongated, nearly as long as first tarsal segment, twice as long as outer; metatibiae in male with spurs slender, acicular, inner one distinctly longer than outer. Protarsi in male with first segment acutely, angularly produced mesad. Antennae very short, scarcely reaching behind middle of prothorax; scape robust, feebly clavate, extending one-third across eye; second and third segments together about as long as first, second half as long as third; fourth and following slightly shorter than third, gradually more robust and subcompressed.

Length: 15 mm.
Type locality: Western Texas.
Distribution: West Texas and New Mexico.
Texan localities: 1; El Paso, Oct. 4, 1935.

TRIBE EPICAUTINI

Body form elongate, cylindrical. Head wider than pronotum, usually distinctly so, sides rounded or straight and feebly divergent or convergent to eyes; front planate, frequently with a median sulcus, sculpturing always simple. Eye variable, ovate to strongly transverse and bilobed. Pronotum subquadrate or slightly elongate, never strongly tumid posteriorly nor depressed anteriorly. Elytra fully developed, occasionally more or less abbreviated; sculpturing consisting of simple punctures, in *Pleuropompha*, however, distinct costae are present; hind wings occasionally absent or reduced. Legs moderate in length, the hind ones more elongate, metafemora not nearly attaining apex of elytra; profemora on undersurface before apex with a patch of dense silky hairs; protarsi sometimes modified in male. Antennae usually

surpassing base of elytra, most frequently distinctly so, filiform, gradually clavate, or, rarely, moniliform; scape variable in length, often greatly elongate in male.

KEY TO TEXAN GENERA

1. Elytra with several prominent costae; antennal segments 3-5 elongated, together longer than rest of segments united; body with some scale-like hairs, especially on upper surface ..... *Pleuropompha*
   Elytra without costae; antennal segments 3-5 not elongate, third sometimes longest segment, but never as above; entire body devoid of scale-like vestiture 2
2. Pronotum strongly transverse, one-third wider than long, each side of disk with a distinct, broad fovea; elytral base viewed from side distinctly elevated above plane of pronotum ..... *Maculicauta*
   Pronotum never much wider than long, disk not distinctly foveate each side 3
3. Metacoxae at insertion of trochanter posteriorly so as to be nearly equal in elevation to the mesocoxae; hindwings wanting; metasternum consequently greatly reduced in length ..... *Henous*
   Metacoxae at insertion of trochanter scarcely half the height of mesocoxae; winged; metasternum elongate ..... *Epicauta*

PLEUROPOMPHA LeConte

Pleuropompha Leconte, Smiths. Misc. Coll. 3:273, 1862. VanDyke, Univ. Cal. Publ. Ent. 4:400, 404, 1928. Werner, Psyche 50:30-33, 1943.

Head with sides parallel to eyes; front feebly convex, as long as head is wide; eye elongate, narrow, not so long as interocular width, bimarginate. Pronotum campanuliform, at least one-fifth longer than wide; disk tumid, with a longitudinal median sulcus. Elytra with three or four strongly elevated costae on disk and sides; apices broadly rounded. All tibiae with two spurs in both sexes, those of metatibiae concave apically and truncate, the outer one more robust. Protarsi and mesotarsi much longer than tibiae, the first segment as long as the next two together; metatarsi slightly longer than metatibiae, the first segment longer than next two together. Antennae with third segment longer than scape, second, fourth, and fifth longer than rest, although scarcely so in female; segments beginning with sixth densely poriferous.

Genotype: Lytta costata LeConte, by monotypy.

KEY TO TEXAN SPECIES

Elytra each with four prominent costae, distinctly connected apically ..... *costata*
Elytra each with three prominent costae, at most feebly connected apically ..... *tricostata*

PLEUROPOMPHA COSTATA (LeConte)

Lytta costata LeConte, Proc. Acad. Nat. Sci. Phila. 7:84, 1854; Journ. Acad. Nat. Sci. Phila. (2) 4:23, 1858. *Pleuropompha costata* (LeConte). LeConte, Smiths. Misc. Coll. 3:273, 1862. Werner, Psyche 50:31, 1944.

Fuscous to piceous, rather densely covered with white scales and adpressed setae, on the elytra denser on the costae and sparse on the intervals; pronotum often with one or more small, glabrous maculae each side of disk. Antennae moderately shining, fuscous. Labrum, apices of mandibles, and most of tarsi black. Lower surface of body with erect setae.

Head with median line deep, distinct, entire; eye in length equal to two-thirds interocular width, distinctly narrower than infraocular space. Pronotum

one-fifth longer than wide; disk on each side strongly tumid basally, feebly impressed anteriorly; sides irregular, feebly widened at middle, arcuately constricted at apex. Elytra with sutural margin strongly costate; each disk with two prominent costae which usually unite with one another and with the two similar costae on the side which extend from behind humerus; apices angularly rounded. Antennae in male with second segment nearly as long as scape; third, fourth, and fifth subequal or successively shorter, each much longer than scape.

Length: 15-18.5 mm.
Type locality: "Frontera."
Distribution: Arizona to west Texas.
Texan localities: 1; Big Bend Region. 1; Van Horn. 4; Alpine; [MU—2, USNM—2]. 1; Marfa; [USNM]. Occurs from July to September; known to attack *Solanum eleagnifolium.*

PLEUROPOMPHA TRICOSTATA Werner

Pleuropompha tricostata Werner, Psyche 50:31, 32, 1943.

Dark reddish-brown to piceous, rather densely covered with pale yellowish-gray scales and adpressed setae, more sparsely so on costal interspaces of elytra. Antennae, palpi, eyes, gula, and sometimes tarsi apically and beneath, blackish.

Head with median impressed line distinct, somewhat feebler above clypeus; eye in length scarcely equal to more than three-fifths of interocular width. Pronotum about one-half again as long as wide; disk on each side rather tumid basally, distinctly impressed at apical fourth; sides nearly parallel on basal half, strongly converging anteriorly. Elytra with sutural margin in part costate; each disk with two strongly elevated costae which are not joined apically with one another nor with the one which extends on the side from behind humerus; apices evenly semicircular. Antennae with third segment a little longer than scape; second, fourth, and fifth distinctly longer than sixth and following segments in male, scarcely so in female.

Length: 9-12.5 mm.
Type locality: Presidio, Texas.
Distribution: New Mexico, Arizona, and west Texas to Mexico.
Texan localities: 1; Castolon. 8; Marathon, M. Cazier; [AMNH]. 2; Presidio; [USNM]. Occurs from June to October; on *Datura quercifolia.*

HENOUS Haldeman

Henous Haldeman, Stansbury's Exped. Surv. Great Salt L. Val.:377, 1852. *Epicauta* Dejean. Werner, Bull. Mus. Comp. Zool. 95:422, 426, 1945 [ex parte].

Head with sides parallel to eyes; front moderately convex, not quite so long as width of head; eye narrow, feebly S-shaped, in length not nearly equal to interocular width. Pronotum as long as wide, base strongly emarginate. Scutellum very narrow, sublinear. Elytra abbreviated, more or less inflated, usually connate along suture; apices obliquely emarginately truncate near suture, rounded laterally. Hind wings wanting. Metacoxae nearly as large as mesocoxae; all tibiae with two spurs in both sexes, those of metatibiae stout, the outer one enlarged, truncate and concave at apex. Pro- and mesotarsi much longer than corresponding tibiae; metatarsi subequal to metatibiae. Antennae with second segment about half as long as scape, which is distinctly

shorter than third; fourth to sixth segments about equal to second; remaining segments longer in male, subequal in female.

Genotype: Henous techanus Haldeman, by monotypy [= *Meloë confertus* Say].

On the basis of the structure of the elytra, metasternum, and especially the metacoxae, in addition to the wingless condition, and convex front, this genus deserves to be separated from *Epicauta*. Werner was, however,, quite correct in placing it in the Epicautini.

HENOUS CONFERTUS (Say)

Meloë confertus Say, Journ. Acad. Nat. Sci. Phila. 3:28, 1824. *Henous techanus* Haldeman, Stansbury's Exped. Great Salt L. Val.:377, pl. 9, f. 12-14, 1852. *Henous confertus* (Say). LeConte, Proc. Acad. Nat. Sci. Phila. 6:330, 1853. VanDyke, Univ. Cal. Publ. Ent. 4:411, pl. 15, f. 1, 1928. *Epicauta conferta* (Say). Werner, Bull. Mus. Comp. Zool. 95:448, 1945.

Black, sparsely clothed with black setae; antennae often fuscous or piceous. Entire upper surface densely, reticularly punctate. Head with punctation somewhat coarser on lower half; antennal callosities distinct, glabrous, polished. Pronotum with sides gradually wider anteriorly, thence suddenly constricted on apical fifth; base broadly emarginate; median line impressed behind middle. Elytra connate, (the union is a weak one, however, and can be broken).

Length: 12-19 mm.

Type locality: Council Bluffs, Iowa, and near the Rocky Mountains [*confertus*]; Texas [*techanus*].

Distribution: Iowa and Arkansas, west to the Rocky Mountains and south into Mexico.

Texan localities: 14; College Station. 6; McLennan Co. 1; Taylor. 2; Berclair. 2; Bexar Co. 1; Griner's Co. 1; Columbus; [AMNH]. 2; Austin; [AMNH]. 1; Forestburg; [MU]. 3; Dallas; [MU]. 2; Blanco Co.; [MU]. Captured from April to September.

Remarks: Werner's description of the antennal segments is in error; the fourth segment is not nearly so long as the third, being only equal to the second.

EPICAUTA Dejean

Epicauta Dejean, Cat. Col.:224, 1833. Horn, Proc. Amer. Phil. Soc. 13:97, 1873. Werner, Bull. Mus. Comp. Zool. 95:421-517, 1945. *Causima* Dejean, Cat. Col., 3rd. ed.:248, 1837. *Isopentra* Mulsant, Opusc. Ent. 8:106, 1858. *Macrobasis* LeConte, Journ. Acad. Nat. Sci. Phila. (2) 4:39, 1858.

Small to rather large, cylindrical, usually slender forms. Head distinctly transverse; front occasionally with an impressed median line, sculpturing mostly simple, consisting of punctures or minute wrinkles; eyes variable in size and shape in the various groups. Pronotum usually but little longer or shorter than wide, anteriorly constricted; disk feebly convex, sometimes with a median sulcus, usually with a central basal impression or fovea. Scutellum usually small. Elytra never inflated nor connate; disk finely punctate or alutaceous, never distinctly costate; apices simply rounded; hind wings normally present. Metasternum elongate. Legs moderate in length, the hind pairs successively longer; metacoxae poorly developed, at *insertion* of trochanter scarcely equal to half the elevation of mesocoxae; profemora with a dense

patch of sericeous pubescence. Protibial and metatibial spurs variously modified. Antennae at least attaining base of elytra; scape sometimes short, sometime greatly elongated, especially in the male.

Genotype: Lytta erythrocephala Pallas, designated by Werner, 1945.

Remarks: In previous studies of this genus, much stress was laid on antennal characteristics, especially the relative lengths of the second and third segments and the elongation of the scape. Only too often these modifications were secondary sexual characters or unstable; in other cases, intermediate conditions occurred which could not be placed with certainty. Hence, a search was made for a more reliable basis of classification.

During the course of the study of these Texan members of the genus—which in number include about half the known North American species— it was observed that the eye was apparently of three distinct types. This character, plus the relative lengths of the third and first antennal segments, was utilized in the following arrangements of the species and might prove applicable to all the American members of the genus.

KEY TO TEXAN SPECIES

1. Eyes at least as long as the width of the interocular space, usually distinctly longer 2
   Eyes not so long as the width of the interocular space, usually at most only two-thirds as long 27
2. Antennae with third segment longer than first, usually distinctly so ..... Group III 3
   Antennae with third segment distinctly shorter than first ..... Group IV (*Macrobasis*) 7
3. Testaceous; the pronotum and elytra blackish vittae 4
   Ferruginous to piceous; pronotum and elytra without dark vittae 5
4. Protibiae and protarsi naked and highly polished on anterior face; antennae with intermediate segments flattened and expanded ..... *occidentalis*
   Protibiae and protarsi hirsute; antennal segments not flattened nor expanded ..... *lemniscata*
5. Elytra with a fine median vitta of denser pubescence; eye about three times as long as interocular width ..... *alastor*
   Elytra not vittate; eye not more than one and one-half times as long as interocular width 6
6. Elytra with a dark band across base from scutellum to humerus; male and female with two protibial spurs ..... *brunnea*
   Elytra with a dark scutellar macula at base, not attaining humerus; male with only one protibial spur ..... *innomina*
7. Antennae short, scarcely surpassing base of elytra, segments from second moniliform; surface of body bright ferruginous, sparsely pubescent ..... *ochrea*
   Antennae long, distinctly surpassing basal fifth of elytra, segments never moniliform; body surface variously pigmented, rarely only sparsely pubescent 8
8. Surface of entire body black or blackish 9
   Surface of body at least in part fuscous, fulvous, or ferruginous 20
9. Elytra with at least a fine vitta of pale pubescence 10
   Elytra devoid of pale vittae 11
10. Elytral vitta very narrow; legs pale ferruginous ..... *hirsutipubescens*
    Elytra with several broad vittae; legs blackish ..... *atrivittata*
11. Entire body covered with black pubescence, except margins of pronotum, apices of elytra and scutellum, and apices of sternites, which are white pubescent ..... *segmenta*
    Body not nearly entirely black pubescent 12
12. Antennae with the surface of at least the first two segments distinctly paler than the following 13
    Antennae with surface uniformly colored or at least not paler proximally 14

13. Abdominal sternites 2-5 with transverse median maculae of black pubescence ..... *albida*
Abdominal sternites immaculate ..... *texana*
14. Abdominal sternites with median black pubescent markings 15
Abdominal sternites sometimes denuded medially but never with black pubescent markings 16
15. Pronotum as long as wide, three-fourths as wide as head; eye slightly broader than infraocular area; antennae with basal four segments flattened, especially in male; pronotum with prominent black maculae or entire disk black ..... *megacephala*
Proontum slightly longer than wide, two-thirds as wide as head; eye only as broad as infraocular area; antennae with basal segments not flattened; pronotum with only indistinct blackish maculae ..... *sublineata*
16. Entire body densely covered with pale pubescence 18
Entire body sparsely covered with ashy pubescence, so that the insect appears blackish-gray 17
17. Pronotum strongly transverse, one-third wider than long, subequal in width to head ..... *torsa*
Pronotum as long as wide, one-tenth narrower than head ..... *murinoides*
18. Antennae with second segment nearly or fully as long as third and fourth together ..... *fabrici*
Antennae with second segment subequal to third or but slightly shorter or longer than it 19
19. Pronotum one-fourth longer than wide; eye distinctly narrower than infraocular space ..... *longicollis*
Pronotum only feebly longer than wide or subquadrate; eye as broad as infraocular space ..... *immaculata*
20. Surface of elytra distinctly paler than that of head and pronotum 21
Surface of elytra as dark as, or darker than, that of head and pronotum 24
21. Eye distinctly narrower than infraocular space, only slightly longer than interocular width ..... *alpina*
Eye broader than infraocular space and nearly twice as long as interocular width 22
22. Body orange-brown, the head, pronotum in part, and abdomen somewhat dark; elytra luteous ..... *luteola*
Body black or fuscous, elytra light or dark ferruginous 23
23. Antennae in male with first two segments as long as rest combined; in female scape reaching two-thirds across eye; femora paler than elytra ..... *polingi*
Antennae in male with scape and second segment not so long as rest combined; in female scape reaching three-fourths across eye; femora as dark as elytra ..... *linearis*
24. Body orange-fulvous or ferruginous, elytra much darker, fuscous or blackish 25
Body fulvous or ferruginous, elytra no darker than pronotum 26
25. Elytra blackish pubescent on disk, pale pubescent on sides, base, and apex .... *reinhardi*
Elytra entirely pale gray pubescent, except for basal dark maculae ..... *tenella*
26. Head with median impressed line reaching to clypeus; second antennal segment half as long as first in both sexes, fourth segment equal to third in female ..... *mcreflexi*
Head with median impressed line reaching to middle of front; second antennal segment nearly two-thirds as long as first in male, fourth segment in female longer than third ..... *lauta*
27. Eye broad, broader than infraocular space, oval, with scarcely a trace of an emargination above antenna so that no trace of a separate inner lobe is present ..... Group I 28
Eye with a distinct inner lobe which is always at least feebly narrower than infraocular space, a distinct emargination present above antennae ..... Group II 34
28. Pronotal disk with two glabrous, rounded maculae ..... *callosa*
Pronotum without glabrous markings 29
29. Pronotum with a sparsely black pubescent vitta each side of middle; elytra each usually with two black pubescent vittae ..... *strigosa*
Pronotum and elytra never vittate 30

30. Eye at emargination distinctly broader than supraocular space 33
Eye not so broad as supraocular space 31
31. Antennae distinctly clavate, thickened distally beginning with fourth segment, segments 4-6 scarcely longer than broad ..... *ferruginea*
Antennae at most feebly clavate, segments 4-6 distinctly longer than broad 32
32. Head nearly always reddish above; pubescence black, rarely cinereous, never ferruginous or fulvous ..... *atrata*
Head always unicolorous; pubescence ferruginous or fulvous ..... *pseudocallosa*
33. Metatibiae with both spurs fairly robust, parallel-sided, subequal in length and width; antennae with distal segments somewhat longer than wide ..... *sericans*
Metatibiae with outer spur rather robust, inner one spiniform, tapering, acute, the outer one visibly longer than inner; antennae with distal segments about as wide as long ..... *fortis*
34. Body black, entirely black pubescent, or black pubescent with margins of elytra pale 35
Body black or otherwise, not black pubescent 38
35. Metatibial spurs short, expanded and concave apically 36
Metatibial spurs rather long, more or less parallel-sided or tapering apically 37
36. Size 7-12 mm.; protibial spurs ismilar in thickness and shape ..... *pennsylvanica*
Size 16-19 mm.; inner protibial spur distinctly more robust and less tapering than outer ..... *funebris*
37. Elytra margined with cinereous ..... *rudosana*
Elytra uniformly black ..... *corvina*
38. At least elytra with rounded, glabrous maculae 39
At least elytra devoid of rounded, glabrous maculae 44
39. Elytral surface ferruginous, contrasting with a darker pronotum and head 40
Elytral surface black or blackish, concolorous with rest of body 41
40. Elytra somewhat abbreviated, exposing last two abdominal tergites; protibiae in male with only one spur ..... *pallidilabra*
Elytra not abbreviated, normally concealing the abdomen; protibiae with two spurs in both sexes ..... *punctipennis*
41. Elytral glabrous maculae frequently confluent, much broader than the pubescent interspaces ..... *pardalis*
Elytral glabrous maculae usually separated, distinctly narrower than interspaces 42
42. Elytral maculae more or less uniform in size 43
Elytral maculae very unequal in size, minute ones interspersed among large ones ..... *normalis*
43. Glabrous maculae of head and pronotum much more densely placed than those of elytra; tibiae and tarsi fuscous; sterna with distinct glabrous maculae ..... *cazieri*
Glabrous maculae of head and pronotum smaller but not much more densely placed than those of elytra; tibiae and tarsi black; sterna immaculate ..... *maculata*
44. Upper body surface uniformly black 45
At least elytra ferruginous, fulvous, or orange-brown 46
45. Elytra with extreme base narrowly black 48
Elytra immaculate at base ..... *uniforma*
46. Entire upper surface uniformly reddish-brown ..... *nigritarsis*
At least head darker than rest of upper surface 47
47. Pronotum uniformly ferruginous; antennae with third segment longer than first, segments from sixth gradually shortened ..... *insignis*
Pronotum blackish on anterior portion; antennae with third segment equal to first, fifth and following subequal in length ..... *hesitata*
48. Pronotum uniformly pubescent, immaculate ..... *pseudosolani*
Pronotal disk with a distinct glabrous callosity each side of middle ..... *candidata*

GROUP I

In this group the eye is much shorter than the interocular width and is strongly oblique and subovate, with the suprantennal emargination relatively poorly indicated, so that the eye fails to present the typical bilobed appear-

ance; it is always wider than infraocular space. The antennae are short, scarcely surpassing base of elytra, often (but not always) clavate, the third segment being distinctly longer than the first. The pronotum is narrower than the head, either a little longer or a little shorter than wide. Protibiae with two spurs in both sexes. Elytra without basal maculae.

EPICAUTA STRIGOSA (Gyllenhal)

Lytta strigosa Gyllenhal, *in* Schoenherr's Syn. Ins. 3:18, 1817. LeConte, Proc. Acad. Nat. Sci. Phila. 6:341, 1853. *Cantharis nigricornis* Melsheimer, Proc. Acad. Nat. Sci. Phila. 3:53, 1847. *Epicauta strigosa* (Gyllenhal). Horn, Proc. Am. Philos. Soc. 13:97, 1873. Werner, Bull. Mus. Comp. Zool. 90: 467, 1945.

Black, covered with dense, but rather short, dull ferruginous-gray or dull fulvous-gray pubescence, letting the surface color show through. Pronotum usually with a sparsely black pubescent vitta each side of middle on disk. Elytra each with two black pubescent vittae, sometimes broad, sometimes narrow or absent. Rest of body black or fuscous.

Entire upper surface coarsely reticularly punctate and minutely alutaceous. Head one-third to two-fifths wider than long, sides divergent to eyes, which are large, ovate, suberect, inner lobe obsolete, length equal to about two-thirds interocular width, broader than supraocular space. Pronotum one-ninth longer than wide, and one-tenth narrower than head, sides nearly straight, subparallel, constricted on apical sixth; disk rather evenly convex, with a feeble median impressed line, sometimes obscured, basal impression shallow, indistinct. Protibiae with anterior spur slightly longer than posterior; metatibial spurs flattened on inner face, subequal, slender, parallel-sided. Antennae slightly surpassing elytral base, segments compact, widened to fifth or sixth segment, thence uniform to apex; scape reaching one-third across eye, second segment one-half as long as first; third nearly as long as first; rest subequal, slightly longer than second, always a little longer than wide.

Length: 7-10 mm.

Type locality: North America [*strigosa*]; Alabama [*nigricornis*].

Distribution: Massachusetts; North Carolina to east Texas.

Texan localities: 1; Columbus [USNM]. 1; Beaumont [USNM]. Occurs in July.

Remarks: The striped individuals are easily recognizable by the coloration; unicolorous specimens can be identified by their large eyes, broad head, thick antennae, simple metatibial spurs, and dark legs.

EPICAUTA CALLOSA LeConte

Epicauta callosa LeConte, Smiths. Misc. Coll. 6(167):158, 1866. Horn, Proc. Am. Phil. Soc. 13:99, 1873. Werner, Bull. Mus. Comp. Zool. 90:468, 1945.

Black, entirely covered with rather dense ochraceous or ferruginous (rarely yellow-cinereous) pubescence, except for two glabrous callosities on disk of pronotum. Elytra without dark basal markings. Antennae and tarsi (largely) glabrous or dark pubescent, surface coloring often fuscous or piceous.

Entire upper surface rather finely, densely punctate except on pronotal callosities; head and pronotum minutely punctulate as well; elytra alutaceous on interspaces. Head one-third wider than long, with sides rounded to eyes, median sulcus indistinct; eye about three-fifths as long as interocular width, about as broad as supraocular and infraocular areas, distinctly emarginate.

Pronotum a little broader than long, nearly as wide at base as at head, sides parallel, obliquely narrowed anteriorly; disk with a distinct median sulcus, a feeble impression basally and a distinct impression each side. Tibial spurs all rather short, flattened internally, subequal; first tarsal segments without pale pads. Antennae scarcely surpassing base of elytra; uniform in thickness; scape reaching one-third across eye; second segment half length of first, a little longer than wide; third about as long as first; remaining segments two-thirds as long as third, eleventh slightly longer; in female fifth and following segments (except last) gradually decreasing in length.

Length: 7-13 mm.

Type locality: Nebraska.

Distribution: Nebraska, Kansas, Oklahoma, and Texas, to Mexico.

Texan localities: 5; Clarendon. 8; McLannan Co. 5; Taylor. 5; College Station. 1; Pompa. 1; Montgomery. 4; Waco. 3; McKinney Co. 3; Dallas; [MU]. 2; Bonham. 2; Amarillo [USNM—1]. 1; Sherman. 1; Fort Worth. 1; Howe. 2; Goldthwaite. 1; Catarina. 3; Waxahachie. 8; Carrizo Spring, Dimmit Co. [AMNH]. 2; Brownwood; [AMNH]. 1; Wharton, Wharton Co. [AMNH]. 1; San Antonio; [AMNH]. 2; Forestburg; [MU]. 2; Harris Co.; [MU]. 1; Corpus Christi; [MU]. 1; Edna; [USNM]. 1; Sinton; [USNM]. 1; Greenville; [USNM]. 1; Sharpsburg; [USNM]. 1; Alpine; [USNM]. 1; New Braunfels; [USNM]. 3; Banque; [USNM]. Occurs from April to September; on *Helianthus argophilus, Malvastrum wrightii* and *Verbesina encelioides.*

Remarks: Distinguished at once by the two glabrous callosities of the pronotum and by the short antennae.

EPICAUTA SERICANS LeConte

Epicauta sericans LeConte, Smiths. Misc. Coll. 167:158, 1866. Horn, Proc. Am. Phil. Soc. 13:98, 1873. Werner, Bull. Mus. Comp. Zool. 90:469, 1945.

Black, base of first metatarsal segment pale; uniformly and rather densely covered with pale ashy-gray to pale ochraceous, often silky pubesecnce. Elytra without dark markings. Antennae pale pubescent on first two segments and on base of third.

Upper surface finely, densely punctate and densely, minutely alutaceous, the elytra more roughly so than other parts. Head with sides rounded to eyes, median sulcus visible above; eye broadly ovate, scarcely emarginate, much broader than head above it, as long as two-thirds the width of front. Pronotum about as long as broad, often nearly as wide as head across occiput, sides feebly convergent anteriorly, arcuately narrowed at apex; disk feebly concave along middle but median line usually absent, basal impression rather feeble. Protibiae with outer spur longer than inner; mesotibial spurs subequal, the outer one more robust; metatibiae with inner spur at most feebly longer than outer, outer one slightly widened apically, usually equally robust as inner. Antennae scarcely attaining base of elytra, gradually thickened to ninth segment; scape reaching one-fourth across eye in female, one-third in male; second segment half as long as first; third a little shorter than first, attaining hind margin of eye in male, not quite attaining it in female; fourth segment a little longer than second; fifth slightly longer than fourth in female, subequal to fourth in male; remaining segments in male slightly shorter than fourth, ninth and tenth about as wide as long, eleventh a little longer than fifth; sixth to eleventh segments in female subequal to fourth, none as wide as long.

Length: 8-13 mm.
Type locality: Kansas.
Distribution: Indiana and Alabama, west to the Rockies.
Texan localities: 7; McLennan Co. 2; Guadalupe Co. 1; Sherman. 2; College Station. 3; Dickinson. 1; Taylor. 1; Vernon. 1; Madison Co. 1; Fort Worth. 3; Forestburg; [MU]. 2; Harris Co. [MU]. 2; Caldwell Co. [USNM]. 1; Bastrop Co. [USNM]. Occurs from May to September; on bean leaves.

Remarks: Distinguished by the uniform pubescence, the lack of dark elytral markings, the broad pronotum, the short antennae which widen apically, and the large eye. In addition the metatibial spurs are subequal, the inner one at most feebly longer than the outer and usually as stout as it.

EPICAUTA FORTIS Werner

Epicauta fortis Werner, Psyche 50:69, 1944; Bull. Mus. Comp. Zool. 95:466, 1945.

Black, covered with pale brown-ashy pubescence. Elytra without dark markings. Antennae with pale pubescence only on mesal surface of first and second segments, pubescence lacking on third.

Exactly as in *sericans* except as follows: Eye a little less broadly ovate. Pronotum one-tenth narrower than head, sides parallel except at apex. Metatibiae with outer spur distinctly longer and broader than inner, which is strongly tapering and slender. Antennae scarcely attaining base of elytra; segments 6-10 shorter than fourth, about as wide as long.

Length: 7 mm.
Type locality: Phoenix, Arizona.
Distribution: Arizona, New Mexico, and west Texas.
Texan localities: 1; Groom, Sept. 17, 1931.

Remarks: Differs from *sericans* mainly in the smaller size and in the form of the metatibial spurs.

EPICAUTA FERRUGINEA (Say)

Lytta ferruginea Say, Journ. Acad. Nat. Sci. Phila. 3:298, 1823. LeConte, Proc. Acad. Nat. Sci. Phila. 6:341, 1853. *Epicauta ferruginea* (Say). Horn, Proc. Am. Philos. Soc. 13:98, 1873.

Black, rather densely and roughly covered with fulvous or pale grayish pubescence. Elytra without basal maculae. Antennae, tibiae, and tarsi fuscous.

Upper surface rather densely, finely punctate and densely, minutely alutaceous. Head one-fifth broader than long, sides slightly divergent to eyes, median line extending to middle of front; eye as long as two-thirds of interocular width, rather narrowly ovate, not as broad as infraocular space. Pronotum about as long as broad, not quite so broad as head, sides parallel to apical fourth, thence narrowed to apex; disk with median impressed line feeble, basal impression sublinear, shallow. Protibiae in male with a single spur, the outer apical angle of tibia strongly produced, spurlike; metatibiae with inner spur slender, spiniform, flattened on inner surface, outer spur very robust, its apex obliquely truncate, ovate. Antennae scarcely reaching base of elytra; robust, thickened beyond third segment; scape reaching one-fourth across eye; second segment half as long as first; third nearly as long as first; remaining segments subequal, as long as second; last segment as long as first.

Length: 6-9 mm.
Type locality: Missouri River.
Distribution: From Iowa to Idaho, south to Arizona and Texas.
Texan localities: 2; Clarendon; [USNM]. 2; Corpus Christi; [USNM].

Epicauta pseudocallosa, new species

Black or fuscous, uniformly covered with ferruginous pubescence. Elytra without dark pubescent, basal markings. Antennae and tarsi ferruginous pubescent only on first two segments.

Entire upper surface rather finely, densely punctate and minutely alutaceous. Head one-third broader than long, with sides convergent to eyes, median sulcus nearly wanting, visible at vertex and at middle of front; eye two-thirds as long as interocular distance, not quite so wide as supraocular space. Pronotum as wide as head, about as long as wide, sides not quite parallel, a little broadened basally, strongly but arcuately so apically; disk with a distinct median sulcus except at apex, basally distinctly impressed. Protibiae with inner spur distinctly longer than outer, those of other legs flattened, rather short, the outer slightly longer. Antennae with first segment reaching one-third across eye; second about half as long; third nearly as long as first two together; fourth nearly as long as first; remaining segment slightly shorter, subequal in length, gradually decreasing in width; last segment a little longer than fourth.

Length: 11 mm.
Holotype: Male (?); McLennan Co., Texas.

Remarks: Closely related to *E. callosa* in the form of the eye, short antennae, shape of pronotum, and in coloration, but differs in lacking glabrous callosities on pronotum, in the tapering and differently proportioned antennae, and in the form of the tibial spurs.

EPICAUTA ATRATA (Fabricius)

Lytta atrata Fabricius, Syst. Ent.:260, 1775; Spec. Ins. 1:329, 1781. Staig, Fab. Types. Hunterian Coll. 2:135, pl. 55, 1940. *Epicauta atrata* (Fabricius). Werner, Bull. Mus. Comp. Zool. 95:470, fig. 18, 1945. *Meloë trichus* Pallas, Icones Ins.:100, pl. E, f. 32, 1789. *Lytta coracina* Illiger, Mag. Ins-kund. 3:171, 1804. *Lytta atrata* var. *convolvuli* Melsheimer, Proc. Acad. Nat. Sci. Phila. 3:53, 1847. *Epicauta convolvuli* (Melsheimer). LeConte, Smiths. Misc. Coll. 6:157, 1866.

Body surface varying from dark reddish-brown to black, that of head above usually reddish, sometimes entirely dark; body covered with blackish pubescence, rarely cinereous in whole or part.

Head with sides feebly rounded to eyes, coarsely, moderately sparsely punctate, in male minutely densely punctate as well; median sulcus confined to vertex; eye nearly oval, scarcely emarginate, in length only slightly exceeding half the interocular width, feebly broader than infraocular space. Pronotum slightly longer than broad, sides arcuately widened to apical fifth, thence strongly narrowed; disk coarsely reticularly punctate and minutely alutaceous, median sulcus visible from apex nearly to base, basal median impression scarcely perceptible. Scutellum as long as broad, or a little longer. Protibiae with inner spur distinctly longer than outer; metatibiae with both spurs truncate and concave at apex, the outer one twice as broad as inner. Antennae scarcely

tapering distally from seventh segment, attaining basal fourth of elytra; scape attaining middle of eye in female, slightly shorter in male; second segment half as long as third, which is longer than first; fourth segment longer than second; remaining segments subequal, except last, which is somewhat elongate.

Length: 7-13 mm.

Type locality: North America [*atrata; coracina*]; North America [*trichrus*]; Georgia [*convolvuli*].

Distribution: Maryland and North Carolina to Nebraska and Texas.

Texan localities: 12; Taylor. 5; College Station. 1; Goldthwaite. 1; Mullen. 1; McLennan Co. 2; Bonham. 1; Brownwood. 1; Eagle Pass. 1; Burleson Co. [MU]. 2; Austin; [MU]. 5; Forestburg; [MU]. 1; Bastrop Co. [USNM]. 1; Commerce; [USNM]. 1; Arlington; [USNM]. 1; Denton; [USNM]. 1; Dallas; [USNM]. 1; New Braunfels; [USNM]. 1; Sabine; [USNM]. Occurs from May to August.

Remarks: The reddish head contrasting with the dark pronotum and elytra will generally serve to distinguish this species. However, when the head is entirely dark, as is sometimes the case, the scarcely emarginate eye and the very unequal, modified metatibial spurs will serve to separate it from the closely related *E. pennsylvanica.*

GROUP II

Eye in length three-fifths to nearly equal to interocular width, transverse, distinctly bilobed, anterior lobe generally longer than posterior, narrower than infraocular space. Antennae always distinctly elongate, strongly surpassing elytral base; third segment as long or longer than, first. Pronotum sometimes elongate. Protibiae often with only a single spur in male. Elytra frequently with basal maculae.

EPICAUTA PENNSYLVANICA (DeGeer)

Cantharis pensylvanica DeGeer, Mem. l'Hist. Ins.5:15, 1775. *Lytta pennsylvanica* (DeGeer). LeConte, Proc. Acad. Nat. Sci. Phila. 6:329, 1853. *Epicauta pennsylvanica* (DeGeer). Horn, Proc. Am. Phil. Soc. 13:102, 1873. *Epicauta pensylvanica* (DeGeer). Werner, Bull. Mus. Comp. Zool. 95:447, 1945. *Meloë nigra* Woodhouse, Med. Repos. 3:213, 1800. [non DeGeer, 1775]. *Lytta morio* LeConte, Proc. Acad. Nat. Sci. Phila. 6:447, 1853.

Fuscous to black, sparsely covered with short, fuscous pubescence. Head with a median, narrow, reddish macula.

Head and pronotum densely, coarsely, reticularly punctate and minutely alutaceous; former with sides feebly rounded to eyes, median sulcus usually visible to clypeus; eye about three-fifths as wide as interocular area, not quite so broad as infraocular space. Pronotum a little longer than wide, sides feebly divergent anteriorly, strongly constricted on apical fifth; disk with median sulcus reaching from base to apex, basal impression shallow. Scutellum short. Protibiae with inner spur distinctly longer than outer; metatibial spurs expanded and concave apically, the outer one only slightly broader near apex than inner. Antennae robust, scarcely tapering apically, attaining basal fifth of elytra; scape reaching middle of eye in male, nearly to hind margin in female; second segment a little more than half as long as third, which is longer than first; fourth and fifth each about three-fourths length of third in female, two-thirds its length in male; remaining segments slightly shorter, except last, which is feebly elongate.

Length: 7.5-12 mm.

Type locality: Pennsylvania [*pennsylvanica*]; Texas [*morio*].

Distribution: From Maine to Florida, west to Montana and Texas.

Texan localities: 12; College Station. 1; Galveston. 4; Amarillo. 1; McLennan Co. 2; Plainview. 4; Austin; [AMNH]. 1; Alvin; [AMNH] 2; Robstown; [USNM]. 1; Goliad Co. [USNM]. Occurs from August to November.

Remarks: LeConte's emendation of DeGeer's obvious misspelling is completely in accord with the Code; consequently, Werner's reversion to the original form is unnecessary.

The form of the eye and metatibial spurs, and the entire frontal sulcus will distinguish this species from black examples of *atrata*.

EPICAUTA FUNEBRIS Horn

Epicauta funebris Horn, Proc. Am. Phil. Soc. 13:102, 1873. Werner, Bull. Mus. Comp. Zool. 95:447, 1945.

Black, covered with short, sparse, fuscous pubescence, denser beneath; head with usual median frontal macula rather small.

Entire upper surface densely, finely, rugosely punctate. Head one-half wider than long, with sides feebly rounded to eye, median sulcus usually distinct to clypeus; eye in length not equal to more than two-thirds the interocular width, about half as broad as infraocular space. Pronotum a little longer than wide, sides subparallel except at apex; disk with a long shallow impression on basal half at middle, median impressed line distinct, confined to apical half. Scutellum narrow, acutely triangular. Protibiae with inner spur distinctly longer than outer; metatibial spurs broadened and concave apically, the outer broader than the inner. Antennae attaining basal quarter of elytra, tapering beyond seventh segment; scape reaching three-fourths across eye in male, beyond hind margin of eye in female; in both sexes second a little more than half as long as third and third as long or feebly longer than scape; fourth slightly longer than second, rest gradually shorter.

Length: 16-19 mm.

Type locality: Texas.

Distribution: Kansas, Oklahoma, Texas, and New Mexico.

Texan localities: 1; Coryell. 2; McKinney. 1; McLennan Co. 2; Valley Mills. 1; Wichita Falls [USNM]. 2; Columbus; [USNM]. Occurs in June and September.

EPICAUTA CORVINA (LeConte)

Lytta corvina LeConte, Journ. Acad. Nat. Sci. Phila. (2) 4:21, 1858. *Epicauta corvina* (LeConte). Horn, Proc. Amer. Phil. Soc. 13:96, 102, 1873. Werner, Bull. Mus. Comp. Zool. 95:446, 1945. *Cantharis nigerrima* Dugès, La Naturaleza 1:162, 1869; 4:66, 1879.

Black, covered with short or rather short, black pubescence. Head on front with a lozenge-shaped, reddish-brown macula.

Entire body minutely alutaceous and rather finely, feebly punctate, more sparsely so on elytra and body beneath. Head with sides convergent to eyes, median sulcus evanescent at center of front; eye in length equal to about four-fifths the interocular width, two-thirds as wide as infraocular space. Pronotum robust, subquadrate, sides gradually divergent anteriorly, constricted at base and apex; median sulcus rather indistinct, deeply impressed at base. Scutellum narrow. Tibiae each with two long spurs, concave on mesal faces, tarsi with first segment as long or longer than next two together. Antennae

with scape in female reaching to hind margin of eye, not so in male, in former second segment about two-thirds length of third (which is shorter than scape), equal to fourth, remaining segments as long as fourth; in male, second segment a little over half length of third (which is as long as scape), shorter than fourth.

Length: 20-27 mm.

Type locality: Valley of the Gila [*corvina*]; Mexico [*nigerrima*].

Distribution: Kansas and west Texas to Arizona and Colorado.

Texan localities: 6; Big Bend Region. 1; Bosque Co. 1; Guadalupe Co. 1; San Angelo. 6; Fort Davis; [MU]. 5; Forestburg; [MU]. 1; Rio Frio; [USNM]. 1; Gainesville; [USNM].

Remarks: This species is very closely similar in appearance to *segmenta*, from which it differs in lacking all trace of white pubesecnce, as well as in the form of the eye and antennae.

EPICAUTA RUIDOSANA Fall

Epicauta ruidosana Fall, Trans. Am. Ent. Soc. 33:258, 1907. Werner, Bull. Mus. Comp. Zool. 95:459, 1945.

Black, head and pronotum shining; covered with short, sparse, black pubescence above. Head in great part, pronotum medially, legs and body beneath covered with long, sparse, cinereous pubescence; the cinereous pubescence strongly condensed on apex and base of pronotum, on entire scutellum, and narrowly on both margins of elytra. On the latter, the lateral margins is no broader than the sutural.

Head rather densely, deeply punctate and densely minutely granulate, sides rounded feebly to eyes; median sulcus attaining clypeus; eye about two-thirds width of front, distinctly narrower than infraocular space, inner emargination broad and pronounced. Pronotum not so long as wide, sides parallel. strongly constricted on apical fifth; disk densely, reticularly punctate and densely granulate, median sulcus concealed, basal impression deep. Protibial spurs subequal, metatibiae with inner spur somewhat longer and stouter than outer. Antennae attaining basal third of elytra, not visibly tapering; scape reaching to middle of eye; second segment half as long as third, which is one-half longer than first; remaining segments as long as first.

Length: 11-16 mm.

Type locality: N. Fork of Ruidoso R., Arizona.

Distribution: Known only from mountains of Arizona and the Chisos Mts. of Texas.

Texan localities: 3; Chisos Mts. 37; Juniper Canyon, Chisos Mts.; [MU].

Remarks: Resembles *E. cinerea* Forst. and *E. solani* Werner (= *E. marginata* auct.) of the eastern and central states, but differs in having the head and pronotum shining, sparsely pubescent; the elytral pale margins narrowly and densely pubescent, the lateral margin no broader than the sutural; and in the different form of the tibial spurs.

Epicauta pallidilabra, new species

Dark brownish-red to piceous, elytra ferruginous; covered with rather sparse, cinereous pubescence, elytra with scattered, irregular, glabrous maculae; labrum quite rufous or pale.

Head one-fourth wider than long, sides arcuate from vertex to eyes, feebly

convergent below, median line entire; eye about two-thirds as long as interocular distance, narrow, about two-thirds as broad as infraocular space. Pronotum just as long as wide, sides subparallel basally, arcuately narrowed to apex from apical fourth; disk sometimes with a distinct median line, basal impression shallow. Elytra somewhat abbreviated, leaving last two tergites exposed. Protibiae with a single, short, straight spur in male, anterior spur slightly longer than hind one in female; metatibial spurs flattened on inner faces, outer spur slightly shorter than inner. Antennae attaining basal fifth of elytra, feebly tapering from middle; scape reaching half way across eye; second segment about one-half as long as third, which is one-sixth longer than first; remaining segments subequal, two-thirds as long as third. Maxillary palpi in male scarcely enlarged, equal to about two-thirds width of labrum.

Length: 13-15 mm.
Holotype: Male; Victoria, Texas; [U. S. National Museum].
Allotype: Female and paratype female; Robstown, May 23; [USNM]. Collected on string beans and cowpea leaves.

Remarks: In appearance and coloration this species resembles *punctipennis;* however, the form of the protibial spurs in the male and the abbreviated elytra place this species near *nogales*. From the latter it differs greatly in coloration.

EPICAUTA PUNCTIPENNIS Werner

Epicauta punctipennis Werner, Psyche 50:68, 1944; Bull. Mus. Comp. Zool. 95:459, 1945.

Fuscous to black, elytra reddish-brown; rather densely covered with moderately short, cinereous pubescence; elytra alone with glabrous maculae, these maculae small, irregularly scattered.

Upper surface densely, reticularly punctate and minutely alutaceous. Head with sides rounded to eyes, median sulcus feebly indicated, confined to lower portion of front; eyes equal to two-thirds interocular width, about two-thirds as broad as infraocular space, inner lobe one-fourth longer than outer; maxillary palpi somewhat enlarged. Pronotum feebly longer than wide, sides subparallel, arcuately constricted from apical third; disk with median sulcus extending from base to apex, basal impression narrow. Scutellum narrow, acutely triangular. Protibiae and metatibiae with inner spur longer than outer. Antennae attaining basal fifth of elytra, not tapering apically; scape reaching to middle of eye; second segment slightly more than half as long as third, which is a little longer than first; fourth segment about two-thirds length of third; remaining segments subequal.

Length: 9-13 mm.
Type locality: Columbus, Texas.
Distribution: Known only from Texas.
Texan localities: 2; College Station. 1; Bexar Co. Occurs in May and June.

Remarks: From the other species with denuded maculae, the present form differs in having reddish-brown elytra, in the obsolete median sulcus of head, in having the maculae confined to elytra, and in the surface sculpturing. It is related to *E. cazieri* in the form of the tibial spurs.

EPICAUTA PARDALIS LeConte

Epicauta pardalis LeConte, Smiths. Misc. Coll. 6:157, 1866. Horn, Proc. Am. Phil. Soc. 13:99, 1873. Champion, Biol. Centr.-Amer. Col. 4(2):414, 1892. Werner, Bull. Mus. Comp. Zool. 95:443, 1945.

Black, shining, rather densely clothed with pale cinereous-gray pubescence; upper and lower surfaces covered with rounded, glabrous maculae, the maculae in part coalescent, for the most part (and always those on the elytra) much broader than the interspaces. Antennae and tibiae fuscous.

Head and pronotum coarsely, sparsely punctate and minutely punctulate; the former with sides feebly rounded to eyes, with median sulcus attaining clypeus; eye about two-thirds as wide as interocular width, distinctly narrower than infraocular area; maxillary palpi only feebly expanded apically in male. Pronotum slightly longer than wide, sides feebly widened to apical third, thence strongly attenuate; disk with median impressed line distinct from base to apex, basal impression obsolete. Scutellum rather small. Elytra with entire surface roughly coriaceous and irregularly punctate. Protibiae in male with a single, short, recurved spur, in female with two spurs, the inner one longer; metatibial spurs short, the outer one a little more robust and shorter than the inner. Antennae extending just beyond base of elytra, feebly tapering apically; scape reaching to middle of eye; second segment a little more than half as long as third, which is four-fifths as long as first; rest subequal, about three-fourths length of third.

Length: 7-12 mm.

Type locality: Valley of the Gila.

Distribution: Arizona and New Mexico to west Texas and Mexico.

Texan localities: 4; Marfa. 1; Canyon. 3; El Paso Co. [KU]. 1; 63 miles south of Alpine; [KU]. Occurs from May to July.

Remarks: Distinct from *E. maculata* in the smaller eye, the larger coalescing maculae, and the fuscous tibiae and antennae, and in the form of the palpi in male.

EPICAUTA NORMALIS Werner

Epicauta normalis Werner, Psyche 50:65, 1944; Bull. Mus. Comp. Zool. 95:442, 1945.

Black, rather sparsely covered with dingy, fulvous-gray or pale gray pubescence; upper and lower surface of body with sparse, widely separated, unequal-sized, glabrous maculae, those on elytra averaging a little larger than those on head and pronotum, which are larger in turn than those of the undersurface.

Head and pronotum coarsely, sparsely punctate and minutely densely punctulate. Head with sides feebly rounded to eyes, median sulcus attaining clypeus; eye equal to about three-fifths of interocular width, narrow, about two-thirds as wide as infraocular space, inner lobe one-half broader than outer. Pronotum just as long as wide, one-ninth narrower than head, sides nearly straight, very feebly narrowing to apical fourth, thence abruptly so to apex; disk with median impressed line distinct medially, basal impression feeble. Protibiae with anterior spur slightly longer than posterior in female, with a single spur in male; metatibiae with both spurs flattened in inner edges, the inner spur longer but no stouter than outer. Antennae attaining basal fourth of elytra; scape reaching half across eye; second segment

a little more than three-fifths as long as first; third feebly longer than first; fourth and following segments subequal, four-fifths as long as third.

Length: 11 mm.
Type locality: Bridgeport, California.
Distribution: Through the Pacific and Rocky Mountain States.
Texan localities: 1; Texas; [USNM]. 1; Llano; [USNM]. Occurs in September.

Remarks: This species is quite closely related to *maculata*. From the latter it differs in having the maculation (of the elytra especially) very unequal in size, fine ones interspersed among larger ones and all widely spaced. The eye has the outer lobe only two-thirds as broad as the inner and the form of the metatibial spurs is different.

EPICAUTA MACULATA (Say)

Lytta maculata Say, Journ. Acad. Nat. Sci. Phila. 3:298, 1823. LeConte, Proc. Acad. Nat. Sci. Phila. 6:340, 1853. *Epicauta maculata* (Say). Horn, Proc. Am. Phil. Soc. 13:100, 1873. Champion, Biol. Centr.-Amer. Col. 4(2):413, 1892. Werner, Bull. Mus. Comp. Zool. 95:441, 1945. *Lytta conspersa* LeConte, Proc. Acad. Nat. Sci. Phila. 6:340, 1853 [non Curtis, 1845].

Black, rather densely clothed with pale cinereous-gray pubescence, sometimes varying to pale olive-cinereous or ashy yellow; upper surface covered with rounded, glabrous maculae for the most part separate and smaller than the interspaces, those on elytra usually more distinct than those of head and pronotum; undersurface often with similar maculae. Legs and antennae piceous or black.

Entire upper surface minutely granulate and rather coarsely punctate. Head with sides feebly rounded to eyes, median sulcus reaching to clypeus; eye about two-thirds as wide as front, about two-thirds as wide as infraocular space, outer portion one-fourth shorter than inner; maxillary palpi in male with apical segments enlarged, the last one as long as half width of front. Pronotum feebly longer than wide, sides gradually divergent anteriorly, strongly constricted on apical fifth; disk with median line distinctly impressed from base to apex, at middle of base a broad, shallow impression. Scutellum narrow, acutely triangular. Protibiae with a single, short, recurved spur in male and two well developed spurs in female, the inner one longer; metatibial spurs subequal in length, the outer one a little more robust. Antennae attaining basal fifth of elytra, very feebly tapering distally from third segment; first segment reaching half-way across eye in both sexes; second a little more than half as long as third, which is feebly longer than first; fourth and following segments subequal, slightly shorter than third.

Length: 9-13 mm.

Type locality: "Missouri and Arkansas, to the Rocky Mountains." [*maculata*] Missouri Territory [*conspersa*].

Distribution: From western Iowa to the Rocky Mountains, south to Guatemala.

Texan localities: 5; Marfa; [USNM—3]. 31; Ft. Davis; [MU—10]. 1; Ben Wheeler. 23; El Paso; [MU]. 1; Perico, Dallam Co. [AMNH]. 1; Marathon; [USNM]. 1; Alpine; [USNM]. 1; Presidio [USNM]. 1; Amarillo; [USNM]. Occurs from May to October. Adults are known to occur on sugarbeets.

Epicauta cazieri, new species

Black, the tibiae and tarsi fuscous; rather densely clothed with cinereous gray pubescence; both body surfaces covered with rounded, glabrous maculae, smaller than the interspaces, except on head and pronotum, where they are no larger but are more densely situated.

Entire upper surface coarsely, sparsely punctate and minutely, densely granulate; elytra somewhat coriaceous as well. Head with sides rounded to eyes, median sulcus extending to clypeus; eye equal to about two-thirds interocular width and two thirds as broad as infraocular space, inner emargination pronounced; maxillary palpi scarcely expanded in either sex. Pronotum about as long as wide, sides distinctly widened to apical third, thence constricted; disk with median impressed line distinct from base to apex. Scutellum moderately narrow, triangular. Protibiae with two subequal spurs in both sexes; metatibiae with inner spur a little longer than outer. Antennae attaining basal fifth of elytra; scape reaching to middle of eye in both sexes; second segment half length of third, which is subequal to first; rest about three-fourths as long as third, subequal, not tapering to apex.

Length: 7-12 mm.

Holotype male, *allotype* female, and five *paratypes.* Sierra Blanca, El Paso Co., June 18, 1947; (Mont Cazier); [American Museum of Natural History].

Remarks: Named for Dr. Mont Cazier, of the American Museum of Natural History, collector of the series of this fine species, to whom the author has often been indebted for study material.

While this species is closely related to *E. maculata,* it differs in the protibial spurs and maxillary palpi being unmodified in the male and in the maculae of the head and pronotum being densely placed, as well as in having the tibiae and tarsi pale.

EPICAUTA UNIFORMA Werner

Epicauta uniforma Werner, Psyche 50:67, 1944; Bull. Mus. Comp. Zool. 95:452, 1945.

Piceous or black, uniformly and rather densely covered with pale fulvous-gray pubescence. Antennae with first two segments and base of third covered to a greater or lesser extent with pale pubescence. Elytra without dark basal maculae.

Entire upper surface densely, finely punctate and densely, minutely alutaceous. Head one-fourth wider than long, sides feebly rounded, and sometimes convergent to eyes, median impressed line distinct to middle of front; eye equal to five-sixths of interocular width, outer lobe much broader than inner, which is distinctly narrower than infraocular space. Pronotum nearly one-fourth longer than wide, and less than one-fifth narrower than head; sides nearly straight and subparallel basally, strongly narrowed on apical third; disk with a distinct median impressed line on basal three-fifths, basal impression triangular, distinct. Protibiae with anterior spur longer than posterior one, especially in male; metatibial spurs subequal, robust, apices obliquely truncate, concave, ovate. Antennae reaching beyond basal third of elytra, tapering from scape to apex; scape attaining hind margin of eye in male, reaching more

than half across eye in female; in both sexes second segment nearly half as long as first; third one-third longer than second; fourth and following segments four-fifths as long as third.

Length: 14-16 mm.

Type locality: Ramak, Arizona.

Distribution: Known from Colorado, Kansas, Texas, and Arizona.

Texan localities: 1; Canutulla, on string bean; [USNM]. 2; El Paso; [CU]. 1; Presidio. Recorded by Werner from Davis Mts., Odell, and Chisos Mts. Occurs from May to August; captured on alfalfa.

Remarks: The above description is based in part also on three specimens from Kansas in the U. S. National Museum, determined by Werner.

Epicauta pseudosolani, new species

Black, densely clothed with yellowish-ashy pubescence. Elytra with extreme base narrowly black. Abdomen in male with black median maculae on abdominal sternites. Legs in male in part black on outer edges. Antennae with first two segments and base of third ashy pubescent.

Head one-third wider than long, sides parallel to eyes, median line feebly impressed, indistinct; eyes narrow, about two-thirds as long as interocular width; antennal callosities small, feebly elevated, denuded. Pronotum as long as broad or feebly longer, sides subparallel, not strongly constricted on apical fourth; disk with median groove usually feeble but distinct, basal impression shallow, subtriangular. Scutellum very small. Metatibial spurs robust, truncate and concave apically, subequal in length and stoutness. Protarsi with first segment somewhat thickened in male, but not shortened. Antennae rather short, robust, tapering apically, scarcely surpassing basal fifth of elytra; scape in both sexes reaching a little more than one-third across eye, rather robust; second segment three-fifths as long as first; third one-fourth longer than first; fourth feebly shorter than first; fifth and sixth segments equal, slightly shorter than fourth; remaining segments gradually decreasing in length and thickness.

Length: 10-14 mm.

Holotype male, *allotype* female, and three *paratypes:* College Station, Texas, Sept. 26-Oct. 26, 1937.

Paratypes: 2; Waco, July 12, 1949, Oct. 6, 1939, on cotton; (P. A. Glick). 1; New Braunfels, May 1902; [USNM].

Remarks: From *pestifera* Werner, this species is distinct in having the metatibial spurs broad and in the form of the antenna. From *E. ficta* Werner which occurs in Oklahoma, it differs in having the antennae tapering to apex, in having larger eyes, the pronotum with a rather distinct median line, and the first tarsal segment of male somewhat broadened.

EPICAUTA CANDIDATA Champion

Epicauta candidata Champion, Biol. Centr.-Amer. Col. 4(2):426, 1892. *Epicauta senilis* Werner, Psyche 56:102, 1949.

Slender; black, densely clothed with pale cinereous-gray pubescence. Pronotum with a denuded macula each side of middle on disk. Elytra with extreme base black pubescent from scutellum to near humerus. Femora and

tibiae on apices, and tarsi on mesal surface, black pubescent. Antennae pale pubescent on first two segments and very sparsely so on third.

Head nearly one-half wider than long, sides parallel to eyes, median line feebly impressed, glabrous, widened for a brief interval above middle of front; eyes about two-thirds as long as interocular width, narrow, two-thirds as wide as infraocular space; antennal callosities small, denuded. Pronotum about as long as wide, subcampanuliform; disk with median impressed line entire, distinct, glabrous, on each side a denuded callosity (forming a macula as described above), basal impression narrow, shallow. Protibiae unmodified in male; metatibial spurs equal in length, the inner one rather robust, spiniform, the outer one more robust, widened apically, apex truncate, concave. Antennae robust, rather short, scarcely surpassing base of elytra, scarcely tapering apically; scape in female reaching halfway across eye; third segment subequal to first, two-fifths longer than second; fourth to tenth slightly longer than second, subequal; eleventh a little longer. Werner describes the scape in the male as extending three-fourths across eye.

Length: 10 mm.

Type locality: Villa Lerdo, Durango, Mexico [*candidata*]; Luna Co., New Mexico [*senilis*].

Distribution: Arizona and New Mexico through west Texas into Mexico.

Texan locality: 1; Presidio, June 12, 1945, on cotton [P. A. Glick].

Remarks: This form is closest to *E. pseudosolani* in the form of eye and the basal maculation of the elytra; from that species it is distinguished by the slender form of the body, and by the two glabrous maculae on the pronotal disk.

The outer metatibial spurs of *E. candidata* were described by Champion as being "spoonshaped," those of *E. sinilis* were referred to by Werner as "sticklike." Both terms apply equally to the single example on hand; hence, the two are synonymized here.

EPICAUTA NIGRITARSIS (LeConte)

Lytta nigritarsis LeConte, Proc. Acad. Nat. Sci. Phila. 6:340, 1853. *Epicauta nigritarsis* (LeConte). Horn, Proc. Am. Phil. Soc. 13:100, 1873. Werner, Bull. Mus. Comp. Zool. 95:438, 1945.

Upper surface uniformly reddish-brown, antennae, apices of femora, and tarsi darker, rest of legs somewhat paler; most of undersurface and sometimes portions of front, black; entirely covered with ashy-white pubescence. Elytra at scutellum with a distinct dark marking, prolonged irregularly across extreme base, reappearing maculiform anteriorly on sides of humerus. Abdomen in almost all males with oblong, dark, transverse maculae on apices of abdominal segments medially; in female immaculate.

Entire upper surface rather finely, densely punctate, and minutely granulate. Head three fourths as long as wide, with sides divergent to eyes, arcuately so in female, median sulcus entire; eye about equal to three-fourths interocular width, narrower than infraocular area, about half width of supraocular space. Pronotum quadrate, at base as wide as head, sides convergent, at apex arcuately narrowed; disk with median sulcus entire, a feeble impression at base. Protibiae in male with a single, short, recurved spur, in female with

two long, straight ones; metatibial spurs concave internally, rather robust, the inner much longer than outer. Antennae attaining basal fourth of elytra (sometimes shorter), first two segments cinereous pubescent, the third one cinereous on inner surface; scape reaching to middle of eye, slightly longer in male; second segment half as long as first; third slightly longer than first in female, distinctly so in male; fourth segment nearly as long as first; remaining segments gradually shorter and narrower.

Length: 10-15 mm.
Type locality: Mexican boundary of Texas.
Distribution: Texas and New Mexico.
Texan localities: 6; Pearsall. 6; Dimmit Co. 1; Johnson Co. 3; College Station. 16; McLellan Co. 1; Donna. 1; Mathis. 1; Belton. 1; Mullen. 1; Sweetwater. 1; Upshur Co. 1; Laredo; [USNM]. 1; Brownwood; [AMNH]. 2; Harris Co. [MU]. 2; Robstown; [USNM]. 2; Uvalde; [USNM—1]. 1; San Diego; [USNM]. 1; New Braunfels; [USNM]. Occurs from May to August. Mesquite is one known host plant.

Remarks: This species is distinguished by the uniform reddish-brown color of the upper surface, combined with paler legs, dark tarsi, and black abdomen, as well as by the quadrate pronotum. The males have a single protibial spur and usually have dark pubescent markings medially on the abdomen.

EPICAUTA INSIGNIS Horn

Epicauta insignis Horn, Trans. Amer. Ent. Soc. 12:110, 1885. Werner, Bull. Mus. Comp. Zool. 95:437, 1945.

Rather robust, fuscous to black, very sparsely ashy pubescent. Pronotum and elytra dark ferruginous; legs paler ferruginous. Elytra with indistinct, dark scutellar and humeral maculae.

Entire upper surface moderately finely, densely punctate, and densely, minutely alutaceous; elytra more obsoletely punctate. Head nearly one-fourth broader than long, sides straight, subparallel to eyes, median impressed line distinct, entire; eyes quite prominent, two-thirds as long as interocular width, feebly narrower than infraocular space; antennal callosities minute. Pronotum subcampanuliform, one-sixth broader than long, constricted at extreme apex, basal margin arcuate; disk with median line distinct, not quite attaining apex, basal impression wanting. Protibiae in male with a single, short, recurved spine; metatibial spurs long, tapering, spiniform, the inner one much longer than outer. Protarsi with first segment elongate, no broader than following. Antennae slender, very feebly tapering to apex, attaining basal fourth of elytra; scape extending nearly two-thirds across eye, robust, nearly straight; second segment nearly half as long as first; third feebly longer than first; fourth and fifth subequal, each about four-fifths as long as third; remaining segments gradually shorter.

Length: 7-10 mm.
Type locality: Arizona.
Distribution: Southern and west Texas to Arizona.
Texan localities: 1; Brownsville; [CU].

Remarks: The single male specimen examined, determined by Werner as this species, differs somewhat from his description of the form in having the pronotum ferruginous and perhaps in the proportions of the antennal segments.

Epicauta hesitata, new species

Ferruginous or dark orange-brown; head, body beneath, and fore part of pronotum to a greater or lesser extent, black; antennae fuscous. Covered rather sparsely with grayish-white pubescence. Elytra with a large scutellar and a smaller humeral dark macula, more or less broadly connected across base; suture scarcely more densely pubescent than disk. Abdomen with a large dark pubescent macula laterally on each sternite.

Upper surface rather coarsely and densely punctate, and minutely alutaceous; elytra subrugose; pronotum reticularly punctate. Head one-fifth broader than long, sides slightly divergent to eyes, median impressed line entire; eyes nearly equal to interocular width, about two-thirds as broad as infraocular space. Pronotum distinctly broader than long, one-ninth narrower than head, sides gradually narrowing to apical sixth, thence constricted to apex, median line entire, rather deeply impressed, basal impression pronounced. Protibiae with a single stout spur in male, in female with two equal, short spurs; meso- and metatibial spurs rather long, slender, simple, flattened on inner faces, inner spur distinctly longer than outer. Protarsi and mesotarsi unmodified in either sex. Antennae slightly surpassing base of elytra, rather robust, feebly tapering from third segment; first segment reaching slightly more than halfway across eye, robust; second segment nearly half as long as first; third equal to first; remaining segments subequal, three-fourths as long as third.

Length: 8-11 mm.
Holotype and *paratype* male: Belton, Texas, April 23, 1933.
Allotype: Female; College Station, June 9, 1933.
Paratype: Female; Upshur Co., June 14, 1927.

Remarks: Apparently this species is quite closely allied to *crassitarsis*, but in the present form the elytra lack the pubescent line, the pubescence is cinereous, the antennal segments are not flattened, the abdominal sternites have large dark maculae on each side, and the mesotarsi are not modified in the male.

GROUP III

Eye in length distinctly exceeding the interocular width. Pronotum narrower than head, always longer than wide. Antennae slender, tapering apically, distinctly attaining basal fourth or third of elytra; scape reaching half or less across eye; third segment always longer than first.

EPICAUTA LEMNISCATA (Fabricius)

Lytta lemniscata Fabricius, Syst. Eleuth:279, 1801. LeConte, Proc. Acad. Nat. Sci. Phila. 6:341, 1853. *Epicauta lemniscata* (Fabricius). Horn, Proc. Am. Phil. Soc. 13:100, 1873. Champion, Biol. Centr.-Amer. Col. 4(2):415, 1892. Werner, Bull. Mus. Comp. Zool. 95:463, 1945.

Testaceous, elytra paler; undersurface largely black. Head with a blackish curved macula each side of vertex. Pronotum occasionally entirely black, but more often testaceous with a black or reddish-brown vitta each side of middle. Elytra with subsutural, submarginal, and discal, black or brown vittae, about equal to or slightly broader than the interspaces. Entirely covered with sparse

yellowish or cinereous pubescence except on dark markings of body above, where the pubescence is black or blackish.

Entire upper surface densely, minutely granulate and rather coarsely, shallowly punctate. Head with sides feebly rounded to eyes, median sulcus nearly attaining clypeus; eye distinctly longer than interocular width, somewhat broader than infraocular area. Pronotum one-third longer than wide, sides parallel to apical fourth, thence constricted to apex; median sulcus extending from base to apex. Scutellum narrow, quadrate. Protibiae with inner spur longer than outer; metatibial spurs modified, concave apically, the outer expanded at apex, protibiae and protarsi distinctly hirsute. Antennae attaining basal third of elytra, tapering apically, the middle segments slightly compressed but not expanded; scape reaching halfway across eye; second segment about half as long as third, which is slightly longer than first; fourth as long as first; remaining segments gradually shorter.

Length: 9-17 mm.

Type locality: North America.

Distribution: New Jersey and Florida to Nebraska, and Texas, into Mexico.

Texan localities: 1; College Station. 2; Burleson Co. 3; Palacios. 1; Hidalgo Co. 2; Dimmit Co. 1; Sumerville. 1; Temple. 1; Pearsall. 1; Big Bend Region. 1; Victoria; [USNM]. 1; Alice; [USNM]. 2; Roma; [USNM]. 3; Victoria Co. [MU]. 1; Brownsville; [MU]. 1; Hays Co. [MU]. 1; Del Rio; [USNM]. 2; Carrizo Springs; [USNM]. 1; Liberty; [USNM]. Occurs from May to October; known to attack tomato and bell peppers.

Remarks: Easily recognized by the unique coloration.

EPICAUTA OCCIDENTALIS Werner

Epicauta occidentalis Werner, Psyche 50:69, 1944; Bull. Mus. Comp. Zool. 95:465, 1945.

Identical with *lemniscata*, except that the pronotum has the sides distinctly widened to apical third and impressed toward base, the middle segments of antennae are strongly flattened and expanded, and the protibiae and protarsi are quite naked and highly polished on anterior face.

Length: 12-15 mm.

Type locality: Cambridge, Nebraska.

Distribution: Known from Kansas, Nebraska, Colorado, Louisiana, and Texas.

Texan localities: 1; Palacios. 1; College Station. 1; Dallas; [MU]. 2; Port Lavaca; [USNM]. 1; Pierce; [USNM]. 1; Liberty; [USNM]. Occurs from June to September; known to attack tomatoes.

EPICAUTA ALASTOR Skinner

Epicauta alastor Skinner, Ent News 15:217, 1904. Werner, Bull. Mus. Comp. Zool. 95:436, 1945.

Dark ferruginous to fuscous, elytra sometimes pale ferruginous; rather sparsely covered with pale ashy- or fulvous-gray pubescence. Elytra each with a fine, entire median vitta and margins more densely pubescent. Legs ferruginous, tarsi and apices of femora and tibiae infuscate.

Entire upper surface densely, finely punctate and minutely alutaceous. Head nearly one-third wider than long, sides rounded from vertex and divergent to eyes, median impressed line reaching only to middle of front; eye about three times as long as the narrow interocular width, about one-third

broader than supraocular and infraocular spaces; antennal callosity narrowly glabrous. Pronotum one-fourth or more longer than wide, four-fifths as wide as head, sides nearly straight and subparallel, strongly narrowed from apical third in male, from apical fifth in female; disk with a distinct, nearly entire median impressed line, basal impression distinct. Scutellum rather narrow. Protibiae without spurs in male, female with two short, equal spurs; metatibial spurs subequal, the inner one slightly more slender, both flattened or concave on inner face, the outer with apex strongly, obliquely truncate, the face of the truncature narrow, parallel-sided. Protarsi in male with first segment short, flattened. Antennae reaching to about basal third of elytra, slender, tapering apically from fourth segment; scape reaching halfway across eye in male, one-third across in female; second segment one-half as long as first in both sexes; third one-fourth longer than first in male, feebly longer than it in female; in male fourth equal to and remaining segments one-fourth shorter than first; in female fourth one-fourth shorter than first, remaining segments subequal, feebly shorter than fourth.

Length: 14-16 mm.
Type locality: Florence, Arizona.
Distribution: From west Texas and Colorado to California.
Texan localities: 3; Presidio, June [USNM].

Remarks: The pale-striped elytra, combined with the elongate-slender form, huge eyes, and short antennal scape, identify this species.

EPICAUTA BRUNNEA Werner

Epicauta brunnea Werner, Psyche 50:67, 1944; Bull. Mus. Comp. Zool. 95:454, 1945.

Fuscous to piceous, the elytra deep ferruginous; entirely covered with dense, fine, ferruginous pubescence. Elytra with a narrow, dark brown band across base from scutellum to near humeri, often concealed by pronotum. Legs in part hoary pubescent as well. Antennae and tarsi piceous.

Head only one-tenth wider than long, sides rounded from vertex to eyes, median impressed line entire; eyes large, in length exceeding the interocular width, broad, much broader than the infraocular space; antennal callosities glabrous, narrowly triangular, rather small. Pronotum at least feebly longer than wide, sides nearly straight, a little widened at apical third, narrowed to apex, hind angles slightly prominent; disk with median sulcus entire, fine, sometimes subobsolete, basal impression small, deep. Protibiae unmodified in male; metatibial spurs spiniform, rather robust, the inner much longer than outer. Protarsi with first segment broader than following, more strongly so in male. Antennae attaining basal fourth of elytra, the last five segments slightly more slender than preceding; scape in male reaching halfway, in female two-fifths across eye; second segment nearly half as long as first; third feebly longer than first; fourth and fifth equal, five-sixths as long as third; remaining segments successively feebly shorter.

Length: 9-16 mm.
Type locality: Alpine, Texas, 6000 ft.
Distribution: West Texas to Arizona and Colorado.
Texan localities: 2; Alpine; [CU]. Occurs in July and August.

Remarks: The large eye and form of the antennae, combined with the brown coloration, will serve as distinguishing characters of the species.

Epicauta innomina, new species

Ferruginous to fuscous, moderately densely covered with pale fulvous pubescence. Elytra with a transverse dark macula at scutellum but without one on humerus.

Surface finely and densely punctate and minutely alutaceous. Head one-fourth broader than long, sides rounded to eyes, median line entire; eye as long as one and one-fourth times the interocular width, distinctly broader than infraocular space and one-fourth narrower than supraocular area. Pronotum one-ninth longer than wide, one-fifth narrower than head, sides subparallel to apical fourth; disk with a fine median impressed line except apically, basal impression sublinear, rather deep. Protibiae in male with a single short spur, in female with two subequal spurs; metatibial spurs flattened on inner face, moderately slender, tapering, not acute, the inner one slightly longer. Protarsi in male with first segment broadly expanded. Antennae reaching to basal fourth of elytra, slender, but only last three segments tapering; scape nearly reaching middle of eye in both sexes, robust; second segment very little more than half length of first; third slightly longer than first; remaining segments subequal, feebly shorter than third; fourth and fifth segments expanded and flattened in male.

Length: 12-14 mm.

Holotype and *paratype* male: Tyler, Texas, July 4, 1937.

Allotype and *paratype* female: Big Bend Region, Texas, Aug., 1928.

Remarks: The paler body coloring, the form of the metatibial spurs, and the modification of the protibiae in the male, will serve to distinguish this species from *brunnea* to which it is most closely allied.

GROUP IV (Macrobasis)

Eye in length distinctly exceeding the interocular width. Pronotum narrower than the head, usually longer than wide. Antennae usually elongate, slender, filiform (short and moniliform in *ochrea*), frequently extending to basal third of elytra; scape almost always reaching two-thirds or more across eye, in male sometimes greatly elongate and modified; third segment never as long as first.

EPICAUTA OCHREA (LeConte)

Lytta ochrea LeConte, Proc. Acad. Nat. Sci. Phila. 6:342, 1853. *Macrobasis ochrea* (LeConte). Horn, Proc. Am. Phil. Soc. 13:91, 1873; Trans. Amer. Ent. Soc. 12:110, 1885. Champion, Biol. Centr.-Amer. Col. 4(2):401, pl. 18, f. 23, 1892. *Epicauta ochrea* (LeConte). Werner, Bull. Mus. Comp. Zool. 95:495, 1945. *Cantharis protarsalis* Dugès, La Nat. 4:63, pl. 2, fig. 7, 8, 1878.

Bright ferruginous or orange-ochraceous, rather sparsely covered with pale cinereous or fulvous-gray pubescence. Antennae, legs, and body beneath dark brownish-red. Elytra at base with indistinct scutellar and humeral maculae.

Head rounded from vertex to eyes, one-fifth wider than long, median sulcus distinct; eye nearly twice as long as interocular width, two-thirds wider than infraocular space and about as wide as supraocular area; antennal callosi-

ties feeble, broadly glabrous, irregular in outline. Pronotum narrowly campanuliform, as long as wide, six-sevenths as wide as head; disk with a distinct median sulcus, not attaining apex, basal impression broad, rather shallow. Scutellum narrow. Protibiae in male with a single, short, robust spur; mesotibial spurs rather short, acute; metatibial spurs subconcave in inner surface, outer spur much shorter than inner. Protarsi with first segment short, contorted in male. Antennae short, scarcely surpassing base of elytra, slightly tapering apically, segments from second moniliform; in male scape distinctly surpassing hind margin of eye, arcuate, apex strongly obliquely truncate; second segment one-sixth as long as first; third one-fourth longer than second; fourth to ninth segments feebly shorter than third, tenth subequal to second, last one slightly elongate; in the female the scape reaches halfway across eye; the second segment one-third as long as first; third more than half as long as first; remaining segments subequal, shorter than third.

Length: 10 mm.

Type locality: Texas [*ochrea*]; Guanajuto [*protarsalis*].

Distribution: West Texas and Mexico to California.

Texan localities: 1; Marfa; [USNM]. 1; Marathon; [USNM]. 2; Alpine; [USNM]. 1; Presidio; [USNM]. 1; Fort Davis; [MU]. Occurs from May to July; on *Yucca*.

Remarks: Distinguished from all other known North American *Epicauta* by the moniliform antennae; the uniformly light body coloring and sparse pubescence are other distinguishing features.

EPICAUTA ATRIVITTATA (LeConte)

Lytta atrivittata LeConte, Proc. Acad. Nat. Sci. Phila. 7:224, 1854. *Macrobasis atrivittata* (LeConte). Horn, Proc. Am. Phil. Soc. 13:90, 1873; Trans. Am. Ent. Soc. 12:110, 1885. *Epicauta atrivittata* (LeConte). Werner, Bull. Mus. Comp. Zool. 95:509, 1945.

Fuscous to black, covered with short, black pubescence, marked with ashy-gray pubescence as follows: Head and pronotum entirely ashy; head with a large black macula each side of vertex; pronotum with a similar macula each side of middle. Elytra with margins (the sutural narrow) and a median vitta on each disk, ashy-gray. Coxae, sterna, and apices of sternites, ashy-gray, as are vittae on femora and on sternal side-pieces.

Head with sides divergent to eyes, median sulcus entire; eyes in length exceeding interocular width by one-half, a little broader than infraocular space. Pronotum one-third longer than wide, sides subparallel to apical third, thence constricted, impressed basally; disk strongly tumid each side at base, basal impression deep, median impressed line absent (or concealed). Scutellum very narrow, sublinear. Protibiae in male with a single short spur; in female the protibiae, and the metatibiae in both sexes, with the inner spur longer than outer. Antennae attaining basal third of elytra; first segment reaching to apical third of pronotum in male, to behind eye in female; second segment as long as fifth; third much shorter; fourth shorter than second in male, subequal in female.

Length: 26-32 mm.

Type locality: "San Diego trip."

Distribution: Texas and New Mexico to Mexico.

Texan localities: 6; Presidio; [USNM—2]. 2; Big Bend region. 1; Sheffield Co. 1; Shovel Mt., Burnett Co. [USNM]. 2; Davis Mts.; [MU]. 2; Rio Grande, Brewster Co. [USNM]. 1; Marathon; [AMNH]. Occurs from April to July; known to attack *Prosopus*.

EPICAUTA SEGMENTA (Say)

Lytta segmenta Say, Journ. Acad. Nat. Sci. Phila. 3:303, 1823. *Epicauta segmenta* (Say). Werner, Bull. Mus. Comp. Zool. 95:490, 1945. *Lytta segmentata* Say. LeConte, Proc. Acad. Nat. Sci. Phila. 6:342, 1853. *Macrobasis segmentata* (Say). Horn, Proc. Am. Phil. Soc. 13:93, 1873. *Apterospasta valida* LeConte, Proc. Acad. Nat. Sci. Phila. 6:342, 1853.

Mostly black, covered with rather long, black pubescence. Head on front medially with a lozenge-shaped reddish-brown macula. Head beneath, mandibles, genae, and occiput white pubescent. Pronotal apex and basal margin, scutellum, elytral apices narrowly, coxae, sterna, and abdominal sternites edged with white pubescence.

Entire upper surface densely, rather finely punctate and minutely alutaecous. Head one-fourth wider than long, with sides rounded to eyes, the median sulcus becoming subcarinate on lower half of front; eye longer than interocular width, nearly as wide as infraocular space. Pronotum very little longer than wide, sides parallel except at apex, where they are strongly constricted; disk with a median sulcus, strongly impressed at base. Tibiae each with two long spurs, concave on mesal faces, less distinctly so in female; tarsi with first segment distinctly longer than next two together. Antennae with scape reaching nearly to (female) or beyond (male) hind margin of eye; second segment half as long as first; third about one-third longer than second in male, subequal to it in female; fourth and following segments subequal, equal to second in male, a little shorter in female.

Length: 15-25 mm.
Type locality: "Purgatory River of the Arkansa" [*segmenta*]; Texas [*valida*].
Distribution: Western Nebraska to Mexico, New Mexico, and Arizona.
Texan localities: 3; Big Bend Region. 5; Chisos Mts.; [USNM—1]. 2; Sweetwater. 1; Marathon. 4; Ft. Davis; [MU—1]. 1; Alpine; [MU]. 2; Glenn Spring, Brewster Co. [MU]:. 1; Jeff Davis Co. [MU]. 2; Marfa; [USNM]. Occurs from June to October.

Remarks: Apterospasta valida LeConte, according to Werner, is the short-winged form of this species; no specimens were encountered during the course of the present study.

EPICAUTA ALBIDA (Say)

Lytta albida Say, Journ. Acad. Nat. Sci. Phila. 3:305, 1823; Amer. Ent. 2nd. ed. I, pl. 3, f. 2, 1824. *Macrobasis albida* (Say). Horn, Proc. Am. Phil. Soc. 13:89, 1873. Champion, Biol. Centr.-Amer. Col. 4(2):397, 1892. *Epicauta albida* (Say). Werner, Bull. Mus. Comp. Zool. 95:511, 1945. *Lytta luteicornis* LeConte, Proc. Acad. Nat. Sci. Phila. 7:84, 1854.

Black, densely covered with pale gray or pale ashy-fulvous pubescence; pronotum usually with a short, black vitta each side of middle. Elytra with black pubescent scutellar (sometimes absent) and humeral spots, and occasionally with indistinct vittae of variable extent. Sterna with maculae, abdominal sternites with transverse median maculae, femora at apex, tibiae externally, and tarsi, black pubescent. Front of head often, mouthparts, antennae, and

palpi, pale ferruginous to orange-brown. Antennae with at least last six segments gradually darker, in female basal two segments only are paler than others, rarely pale. Legs, except tarsi, sometimes orange-brown.

Entire upper surface rather finely, densely punctate and minutely alutaceous. Head subrotund, about one-fifth wider than long, median sulcus entire; antennal callosities glabrous, ovate, nearly as long as the inner margin of eye, which is nearly twice as long as interocular width, narrow, about half width of supraocular space, but as wide as infraocular area. Pronotum about one-fifth longer than wide, occasionally one-fourth longer, four-fifths as wide as head, sides usually feebly widened to apical fourth, thence constricted to apex; disk with scarcely an indication of a median sulcus, basal impression pronounced. Scutellum small. Protibiae and mesotibiae with the outer spur shorter than inner, on protibiae somewhat arcuate; metatibial spurs distinctly stouter than others, flattened on inner face, the inner spur a little longer and more acute than outer. Antennae attaining basal fourth of elytra; in male scape attaining occiput, broadly emarginate externally on apical third, the second segment about one-fourth length of first, third two-thirds as long as second, fourth slightly shorter than and fifth equal to, second, and remaining segments subequal, tapering gradually from second segment; in female scape attaining hind margin of eye, second more than one-third as long, third subequal to second, and fourth and following segments a little longer.

Length: 13-28 mm.

Type locality: "Arkansa, near Rocky Mountains" [*albida*]; Laredo to Ringgold, Texas [*luteicornis*].

Distribution: Kansas to Colorado, southward to Mexico.

Texan localities: 5; College Station. 1; Mexia. 7; McLennan Co. 1; Plainview. 4; Odessa. 1; Dimmit Co. 5; Hidalgo Co. 1; Dickens Co. 1; Madison Co. 1; Dillen. 1; Mathis. 5; Kingsville; [MU]. 2; Del Rio; [MU]. 3; Fort Worth; [MU]. 1; Skellytown, Carson Co. [MU] 2; Brownswood; [AMNH]. 1; Dallas; [USNM]. 1; Victoria; [USNM]. 2; Brownsville; [USNM]. 1; Gregory; [USNM]. 1; Cuero; [USNM]. 1; Amarillo; [USNM]. Occurs from July to October; known to feed on sugar beet and *Cienfuegosia sulphurea.*

Remarks: Distinguished by the antennae being noticeably paler basally, especially in the male, by the narrow eye, the dark legs, and by the dark maculae on abdomen medially.

EPICAUTA TEXANA Werner

Epicauta texana Werner, Psyche 50:73, 1944; Bull. Mus. Comp. Zool. 95:512, 1945.

The only difference observable between this species and *E. albida* is the lack of dark maculae on the undersurface of the latter. All the structures are identical in form and proportions, except that the third antennal segment is only two-thirds as long as second. There is small doubt that the two will prove synonymous.

Length: 18-24 mm.

Type locality: Davis Mts., Texas.

Distribution: West Texas.

Texan localities: 1; McLennan Co. 1; San Antonio; [AMNH]. 1; North Peyote; [USNM]. 1; Alpine; [USNM—paratype]. Taken from June to September; occurs on *Solanum eleaquifolium.*

EPICAUTA SUBLINEATA (LeConte)

Lytta sublineata LeConte, Proc. Acad. Nat. Sci. Phila. 6:447, 1853. *Macrobasis sublineata* (LeConte). Horn, Proc. Am. Phil. Soc. 13:94, 1873; Trans. Amer. Ent. Soc. 12:109, 1885. *Epicauta sublineata* (LeConte). Werner, Bull. Mus. Comp. Zool. 95:491, 1945. *Macrobasis longicollis* LeConte. Champion, Biol. Centr.-Amer. Col. 4(2):397, 1892 [ex parte].

Black, rather densely covered with ashy pubescence. Pronotum each side of middle with an indistinct, blackish, vittiform macula. Elytra becoming in part black or fuscous pubescent apically, with a fine line along suture, two similar lines on disk, and a broader one behind humerus, black. Abdomen with transverse black bands or maculae at middle. Clypeus and palpi luteous. Femora at apices, protibiae externally, mesotibiae, metatibiae, and all tarsi, blackish, the two hind pairs of tibiae with pale setae intermingled towards base.

Head not much wider than long, sides gradually widened to eyes, median sulcus entire; eyes longer than interocular width, as wide as infraocular area, about two-thirds width of supraocular space. Pronotum two-thirds as wide as head, slightly longer than wide, sides feebly widened to apical fourth, thence rounded to apex; disk tumid on each side at base, with a distinct median sulcus, basal impression rather shallow. Protibial spurs rather short; mesotibial spurs much longer, acute; metatibial spurs as long as protibial, flat on inner surface, the outer one shorter and broader. Antennae slender, gradually tapering apically, attaining basal fourth of elytra; scape slender, feebly arcuate, slightly surpassing hind margin of eye in male, not quite attaining it in female; second segment three-fifths length of first; third slightly longer than second in male, distinctly so in female; remaining segments subequal to third in male, slightly shorter than third in female.

Length: 14-15 mm.
Type locality: Eagle Pass, Texas.
Distribution: Texas and Mexico.
Texan localities: 2; Dimmit Co., July and September.
Remarks: When examined with the naked eye, the elytra appear blackish with pale margins and with a powdery gray base.

EPICAUTA MEGACEPHALA Champion

Macrobasis megacephala Champion, Biol. Centr.-Amer. Col. 4(2):402, pl. 18, f. 24, 1892. *Epicauta sublineata* LeConte. Werner, Bull. Mus. Comp. Zool. 95:491, 1945 [ex parte].

Black, densely ashy pubescent. Head sometimes with a large, black spot each side. Pronotum usually with a large, black macula each side of disk, sometimes enlarged so that only the margins and median line are pale pubescent. Elytra black pubescent, except at apices, and, rarely, along suture and side margins and at base. Abdominal sternites in great part black pubescent. Clypeus and palpi luteous to ferruginous. Antennae dark reddish-brown, basal segments sometimes paler than distal ones. Meso- and metafemora in large part or entirely, corresponding tibiae, protibiae posteriorly, and tarsi, black pubescent.

Head one-fourth broader than long, sides rounded to eyes, median sulcus entire; eye distinctly longer than interocular width, feebly broader than infraocular space. Pronotum about three-fourths as wide as head, about as long as

wide, sides feebly divergent to apical third, thence narrowed apically; disk with an indistinct median sulcus, basal impression pronounced. Protibial spurs acute, moderately long, the anterior one a little longer; mesotibial spurs elongate, acute; metatibial spurs concave on inner surface, the inner one slightly longer and a little slenderer than outer. Antennae attaining basal fourth of elytra, tapering from fifth segment; scape strongly surpassing hind margin of eye in male, attaining it in female; second and fourth segments subequal, three-fifths as long as first, fourth stouter than third; third and remaining segments quite distinctly longer than second.

Length: 21-24 mm.

Type locality: Monclova, Mexico.

Distribution: Mexico and southern Texas.

Texan localities: 1; Winter Haven. 1; Dimmit Co. 1; Mathis. 2; Hidalgo Co. [G. B. Vogt]. Collected May to August.

Remarks: Distinct from *sublineata* in the relatively broader pronotum, the antennae with basal four segments flattened somewhat, especially in male, the fourth segment wider and distinctly sharter than third, the scape relatively longer, the slightly broader eye, and the different coloration.

EPICAUTA LONGICOLLIS (LeConte)

Lytta longicollis LeConte, Proc. Acad. Nat. Sci. Phila. 6:343, 1853. *Macrobasis longicollis* (LeConte). Horn, Proc. Am. Phil. Soc. 13:90, 1873; Trans. Amer. Ent. Soc. 12:110, 1885. Champion, Biol. Centr.-Amer. Col. 4(2):397, 1892. *Epicauta longicollis* (LeConte). Werner, Bull. Mus. Comp. Zool. 95:508, 1945.

Black, uniformly covered with dense, cinereous pubescence. Elytra with humeral and scutellar maculae, femora with apices, meso- and metatibiae except on outer margin, and tarsi, black or blackish pubescent. Protibiae and protarsi with pale and blackish pubescence. Antennae fuscous. Palpi luteous to dark ferruginous, mostly pale pubescent.

Entire upper surface finely, densely punctate and minutely alutaceous. Head one-fifth broader than long, sides straight, feebly convergent to eyes, median sulcus entire; antennal callosities moderate in size, glabrous, strongly protuberant in male, flat in female; eye nearly twice width of interocular distance, narrow, distinctly narrower than infraocular space, and about half width of supraocular area. Pronotum one-fifth narrower than head, one-fourth longer than wide, sides nearly straight on basal half, arcuately tapering anteriorly; disk with a fine median sulcus from base to apex, basal impression triangular, extending to middle. Protibiae with a single, slender spur in male, in female inner spur a little longer than outer; metatibial spurs flattened on inner face, the outer spur shorter and more acute than inner. Antennae attaining basal fourth of elytra, gradually tapering from third segment; in male scape slightly surpassing occiput, only feebly widened apically, subcylindrical, bisinuate, second segment one-fifth as long as first, third and fourth slightly longer, fifth and following longer; in female scape attaining hind margin of eye, slightly clavate, as long as next two together, second segment less than half as long as first, third and fourth longer than second, fifth still longer, and remaining segments as long as fourth.

Length: 18-21 mm.

Type locality: Santa Fe, New Mexico.

Distribution: New Mexico and Arizona, into Mexico. Also reported from California.
Texan localities: 1; Castolon. 1; Big Bend Region. 1; Marfa; [USNM]. Occurs in June and July.

Remarks: The form of the antennae, the single protibial spur of the male, and the narrow eye are distinguishing characters of this species. In addition, the meso- and metatibiae are pale pubescent on lateral edge, dark behind, quite the reverse of the condition prevailing in similar appearing species.

EPICAUTA IMMACULATA (Say)

Lytta immaculata Say, Journ. Acad. Nat. Sci. Phila. 3:304. 1823. LeConte, Proc. Acad. Nat. Sci. Phila. 6:342, 1853. *Macrobasis immaculata* (Say). Horn, Proc. Am. Phil. Soc. 13:93, 1873; Trans. Am. Ent. Soc. 12:110, 1885. *Epicauta immaculata* (Say). Werner, Bull. Mus. Comp. Zool. 95:489, 1945. *Lytta articularis* Say. Journ. Acad. Nat. Sci. Phila. 3:304, 1823. *Lytta fulvescens* LeConte, Proc. Acad. Nat. Sci. Phila. 6:447, 1853.

Black, densely covered with cinereous, yellowish-cinereous, or ferruginous pubescence. Elytra often with a blackish macula on humeri and occasionally near scutellum, both variable in size and distinctness. Tibiae and often femora black externally or nearly entirely so; tarsi black to a great but variable extent. Abdominal sternites occasionally denuded medially.

Entire body surface densely, finely punctate. Head about one-fourth wider than long, sides rounded from vertex to eyes; front with an entire median sulcus; antennal callosities in male elongate, triangular, glabrous; eye large, slightly prominent, in length equal to interocular width, as broad as infraocular space. Pronotum subquadrate, as long as or a little longer than wide, sides subparallel, constricted at apex and at extreme base; disk sometimes with a fine median line, basal impression distinct, reaching to basal third, rather deep and narrow. Tibial spurs elongate, slender, spiniform, the inner one larger except on protibiae, where the anterior one is longer. Antennae slender, elongate, tapering beginning with the fifth segment; scape in male elongate, robust, reaching about halfway beyond eye to vertex, in female extending not quite to hind margin of eye; second segment in male about half, in female three-fifths as long as first; second, third, and fourth segments subequal, sometimes second a little shorter or longer than fourth, and sometimes third slightly elongate; remaining segments subequal to fifth, which is feebly shorter than fourth.

Length: 13-25 mm.
Type locality: Arkansas [*immaculata, articularis*]; Texas [*fulvescens*].
Distribution: From Indiana and Kentucky west to New Mexico.
Texan localities: 8; Fort Worth; [MU]. 4; Forestburg; [MU]. 5; Coahoma, Howard Co. [MU]. 1; Del Rio; [MU]. 2; Breckenridge; [MU]. 1; Harris Co. [MU]. 1; Presidio; [USNM]. 1; Gordon; [USNM]. 1; Ft. Stockton; [USNM]. 2; Pyote; [USNM]. 1; Brewster Co. [USNM]. 1; Marble Falls; [USNM]. 1; Childress; [USNM]. 1; Kingsville; [CU]. 4; El Paso; [CU]. 1; Uvalde Co. [OU]. 2; Val Verde Co. [OU]. 2; Davis Mts.; [OU]. Occurs from June to August. Captured on *Asclepias* and *Verbesina*.

EPICAUTA FABRICII (LeConte)

Lytta cinerea Fabricius, Suppl. Ent.:119, 1798 (preoccupied in *Epicauta*). *Lytta fabricii* LeConte, Proc. Acad. Nat. Sci. Phila. 6:343, 1853. *Macrobasis fabricii* (LeConte). Brown, Can. Ent. 72:231, 1940. *Epicauta fabricii* (LeConte). Werner, Bull. Mus. Comp. Zool. 95: 497, 1945. *Lytta debilis* LeConte, Proc. Acad. Nat. Sci. Phila.

6;344, 1853. *Macrobasis unicolor* Kirby. Horn, Proc. Am. Phil. Soc. 13:92, 1873; Trans. Am. Ent. Soc. 12:110, 1885 [ex parte].

Black or fuscous; moderately densely covered with short, ashy pubescence, except on antennae, most of tarsi, and apices of tibiae and femora. Elytra at base with a dark pubescent macula at scutellum and on humeri.

Head as broad as long, flat above, sides feebly convergent to eyes, median impressed line entire, distinct; eye about as long as interocular space, about one and one-half times as wide as infraocular area, half width of supraocular space; antennal callosities large, oval, somewhat tumid in male. Pronotum nearly as wide as head, either a little wider or narrower than long, sides subparallel on basal two-thirds, sometimes impressed basally, strongly tapering apically; disk with a distinct, glabrous median line, sometimes accentuated by a longitudinal impression, basal impression rather small, fairly deep, variable in form. Scutellum rather broad. Protibiae with two subequal spurs, the anterior one feebly arcuate; metatibial spurs rather short, tapering, somewhat flattened on inner surface, inner spur distinctly longer than outer. Antennae reaching to basal third of elytra, tapering beyond middle; male with first two segments flat, shining, scape reaching a little beyond occiput, broad, arcuate; second segment half as long as first, broad, straight or feebly arcuate, longer than third and fourth together; third distinctly shorter than fourth, remaining segments subequal or apical ones feebly longer; female with scape slender, arcuate, slightly surpassing hind margin of eye, second segment not quite equal to next two together, more than half as long as first, third segment slightly shorter than fourth, fifth and following segments subequal, slightly longer than fourth.

Length: 9-14 mm.

Type locality: America [*cinerea; fabricii*]; New York [*debilis*].

Distribution: Maine and Florida, west to Montana and New Mexico.

Texan localities: 9; College Station. 4; Lindale. 8; Palestine. 4; Smith Co. 3; Hallsville. 3; Carthage. 2; El Paso. Occurs from April to July.

Remarks: In addition to the elongate slender form of the body and the uniform gray appearance of the insect, males may be distinguished by the flattened scape which reaches slightly beyond occiput, the second antennal segment being about half length of scape and straight or nearly so. In the female the scape reaches slightly beyond eye, while the second segment is more than half its length, being one and one-third times as long as third.

EPICAUTA TORSA (LeConte)

Lytta torsa LeConte, Proc. Acad. Nat. Sci. Phila. 6:343, 1853. *Macrobasis torsa* (LeConte). Horn, Proc. Am. Phil. Soc. 13:91, 1873. *Epicauta torsa* (LeConte). Werner, Bull. Mus. Comp. Zool. 95: 507, 1945.

Black, rather sparsely clothed with pale gray pubescence. Elytra with indistinct but large, blackish scutellar and humeral maculae. Antennae, palpi, and legs fuscous to piceous; mandibles largely reddish; antennae largely clothed with fuscous pubescence.

Head nearly one-third wider than long, concave at vertex, sides rounded from vertex to eyes, median sulcus distinct from vertex to frontal macula; eye not prominent, rather small, as long as interocular width, two-thirds as wide

as infraocular space, which is nearly as wide as supraocular area; antennal callosities in male rounded, rather large, glabrous. Pronotum strongly transverse, one-third wider than long, very nearly as wide as head, sides feebly widened to apical third, thence strongly constricted to apex; disk somewhat tumid each side basally, median sulcus indistinct, confined to apical half, supplemented before apex by a distinct fovea, basal impression strong, deep, rather narrow, reaching to middle. Scutellum moderately wide. Protarsi in male with a single, robust, acute spur; mesotibial spurs rather short, flattened on inner face, acute; metatibial spurs robust, short, rounded apically, concave on inner face, the inner one slightly longer and stouter. Antennae in male rather robust, slightly tapering distally from the middle, attaining basal third of elytra; scape robust, cylindrical, surpassing occiput, strongly biflexuose, bent at an angle of about sixty degrees near middle, then bent at a similar angle in opposite direction just before apex; second segment robust, two-fifths as long as first, third and following segments subequal, one-half as long as second, and fifth a little longer than others; in the female, the scape reaching hind margin of eye, slightly bent, with a trace of an apical excavation, second segment three-fifths as long as first, and third and following segments three-fourths as long as second.

Length: 15 mm.

Type locality: Texas.

Distribution: From Texas to Florida and North Carolina; also Massachusetts.

Texan localities: 2; Texas; [AMNH; USNM]. 1; Dallas; [USNM]. 1; Dallas Co. [MU].

Remarks: The form of the antennae and the transverse pronotum will serve to separate this species from other black, sparsely pale gray pubescent forms.

Epicauta murinoides, new species

Black, rather densely covered with short, grayish-white pubescence, which apparently is easily rubbed off. Elytra with small, dark humeral and scutellar maculae. Antennae and legs reddish-brown.

Entire upper surface rather densely and finely punctate, minutely, densely alutaceous; elytra subrugose as well. Head one-fifth wider than long, sides well defined, arcuate to eyes, median line distinct to middle of front; eyes distinctly longer than interocular width, about two-thirds as wide as infraocular space; antennal callosities broadly ovate, very large, longer than width of eye. Pronotum about as long as wide, one-tenth narrower than head, sides parallel on basal two-thirds, thence rounded to apex; disk with median line almost entire, basal impression rather large, deep. Scutellum broad. Protibiae with two spiniform, subequal spurs in male; metatibial spurs rather acute, equally stout, the inner faces concave, the inner spur slightly longer than outer. Antennae attaining basal third of elytra, gradually tapering distally from fourth segment; in male first two segments very robust; scape in male attaining occiput, slightly arcuate, gradually widened to apex where it is one-fourth as broad as long; second segment half as long as first, slightly narrowed apically in male, four-sevenths as long as first in female; third one-third as long as second in male, one-fifth shorter than second in female; fourth half as

long as second in male, slightly longer than third in female; remaining segments gradually shorter.

Length: 13 mm.

Holotype and *paratype* males: College Station, Texas, Dec. 1, 1939.

Allotype: Female; topotypic, April 29, 1930.

Paratype: Dryan's Mill, Mar. 19, 1905 [USNM].

Remarks: Closely related to *E. murina* but the scape in the male is more robust, less flattened, one-fourth as broad at apex as long; the second segment is equal only to the next two and a half segments. In the female the second segment is only slightly longer than third, whereas in *murina* it is very nearly as long as the next two together.

EPICAUTA HIRSUTIPUBESCENS (Maydell)

Macrobasis hirsutipubescens Maydell, Trans. Am. Ent. Soc. 60:334, 1934. *Epicauta hirsutipubescens* (Maydell). Werner, Psyche 56:110, 1949. *Epicauta virgulata* (LeConte). Werner, Bull. Mus. Comp. Zool. 95:512, 1945.

Black, rather densely covered with pale ashy or pale fulvous pubescence. Elytra at base with fuscous scutellar and humeral maculae; disk with the pale pubescence condensed to form a narrow vitta. Legs pale ferruginous, tarsi and apices of femora darker. Antenna fuscous, pale pubescent on inner edge of first four segments.

Head one-sixth wider than long, sides short, nearly parallel, feebly divergent to eyes, median impressed line pronounced; eyes prominent, about twice as long as interocular width, one-fourth wider than infraocular space, and subequal to supraocular area; antennal callosities polished, rather large, broadly ovate. Pronotum one-sixth narrower than head, one-tenth longer than wide, weakly campanuliform; disk with a disitnct median impressed line on apical two-thirds, basal impression rather deep, narrow. Scutellum moderately broad. Protarsi in male with a single, recurved spur, in female with two long spurs, the anterior longer; mesotibial spurs rather short, selnder, the inner one longer; metatibial subequal, inner faces flat, the inner spur feebly longer and a little stouter than outer. Antennae attaining basal third of elytra, tapering apically; male with scape arcuate, reaching feebly behind eye, slender, second segment one-fourth to one-fifth as long as first, third three-fifths again as long as second, fourth one-fourth longer than third, fifth and sixth slightly longer than, and seventh subequal to, fourth, and remaining segments feebly shorter than fourth; female with antennae more robust, scape reaching beyond middle of eye, straight or nearly so, second segment nearly half as long as scape, third two-thirds length of first, and remaining segments subequal to third.

Length: 9-12 mm.

Type locality: Texas.

Distribution: Arizona and west Texas.

Texan localities: 2; Marathon; [AMNH]. 11; Davis Mts., Fort Davis Quad.: [MU—7; OU—4]. 4; El Paso; [CU]. 1; Presidio; [USNM]. 2; Glenn Springs, Brewster Co. [MU]. 2; El Paso; [MU]. Occurs in June, July and August; known to attack *Acacia vermicosa.*

Remarks: The antennal formula, the combination of pale legs with a black body, and the fine, pale pubescent vitta of the elytra will distinguish this species.

EPICAUTA ALPINA Werner

Epicauta alpina Werner, Psyche 50:67, 1944; Bull. Mus. Comp. Zool. 95:453, 1945.

Elongate-slender. Black, elytra ferruginous or dark fulvous; antennae, legs, and mouthparts dark reddish-brown, scape darker; entirely densely covered with light fulvous pubescence. Pale pubescent on scape and on inner surface of second antennal segment.

Entire upper surface densely, finely punctate and minutely, densely alutaceous. Head one-ninth wider than long, sides slightly arcuate and feebly convergent to eyes, median impressed line obsolete; eyes slightly longer than interocular width, distinctly narrower than infraocular space. Pronotum slightly longer than wide, nearly as wide as head, sides subparallel, narrowed on apical third; disk strongly convex, median line indistinct, basal impression rather deep. Protibial spurs short, anterior one longer; metatibial spurs stout, inner faces flat, outer spur more robust and more flaring apically than inner. Antennae reaching basal fourth of elytra, rather robust, feebly tapering from third to fifth segments, following segments uniform in width; scape in male reaching slightly behind eye, in female to hind margin of eye; second segment not quite half as long as first; third one-third longer than second; remaining segments slightly shorter than third.

Length: 10-12 mm.
Type locality: Alpine, Texas.
Distribution: West Texas and New Mexico.
Texan localities: 1; Alpine, August; [USNM—paratype].

Epicauta luteola, new species

Orange-brown, head, pronotum in part, and abdomen somewhat darker, elytra, palpi and femora luteous; uniformly covered with pale fulvous-gray pubescence. Antennae fuscous, largely glabrous, except on inner edge of scape. Apices of femora and tibiae somewhat darker. Elytra with small scutellar and humeral spots.

Head distinctly wider than long, sides rounded to eyes, median sulcus entire, distinct; eyes nearly twice width of interocular space, broader than infraocular area and nearly as broad as supraocular area; antennal callosities denuded, rather large. Pronotum one-sixth longer than wide, sides broadly sinuate on basal two-thirds, apically strongly constricted; disk convex, with a distinct median impressed line which does not quite attain base nor apex, basal impression distinct, subtriangular. Scutellum moderately narrow. Protibiae flattened, more or less arcuate, and with but a single spur in male; metatibial spurs rather short, with inner faces concave, the outer one feebly shorter and more tapering; protarsi in male with first segment short and contorted. Antennae surpassing basal fourth of elytra, gradually tapering beyond fourth segment; first two segments flattened, more or less shining, not so long as remaining segments combined; scape surpassing occiput by one-third its own length, arcuate; second segment two-fifths length of first; third, fourth, and sixth segments three fifths length of second, fifth slightly longer; remaining segments distinctly shorter.

Length: 8-9 mm.
Holotype and one *paratype:* Male; Presidio, August 1934, W. L. Thomas.

Remarks: Very closely related to *E. polingi* but differs in having luteous elytra instead of ferruginous, in being smaller in body size, and in the form of the antennae. In the present form the second antennal segment is two-fifths as long as first, the third, fourth, and sixth segments three-fifths as long as second (instead of less than half its length); the first two segments together are distinctly shorter than remaining segments combined.

EPICAUTA POLINGI Werner

Macrobasis linearis LeConte. Horn, Trans, Am. Ent. Soc. 12:109, 110, 1885. *Epicauta polingi* Werner, Psyche 50-71, 1944; Bull. Mus. Comp. Zool. 95:505, 1945.

Black or fuscous, elytra and tibiae ferruginous, femora paler; entirely covered with ashy or pale fuscous-gray pubescence. Elytra with a dark scutellar and a smaller humeral macula. Antennae piceous, first two segments (and sometimes base of third) sparsely ashy pubescent. Palpi luteous to ferruginous. Apices of femora, tibiae, and tarsal segments, dark pubescent.

Head slightly broader than long, rounded above, sides strongly arcuate to eyes, median sulcus entire; eyes much longer than interocular width, distinctly broader anteriorly than infraocular space, but not quite equal to supraocular area. Pronotum distinctly longer than wide, about three-fourths width of head, sides subparallel on basal two-thirds, sometimes impressed, apical third strongly narrowed; disk evenly convex, median impressed line distinct on apical two-thirds, basal impression deep, more or less triangular. Scutellum moderately narrow. Protibiae in male largely denuded, flattened, with but a single spur, in female with two equal, acute spurs; metatibial spurs short, robust, concave on inner surfaces, subequal in length. Antennae attaining basal fourth of elytra, tapering apically; male with first two segments elongate, flattened, robust, rather shining, together about as long as remaining portion of antenna, scape surpassing occiput by one-third its onw length, arcuate, second segment nearly one-third length of first, third to fifth segments about one-half length of second, and sixth to eighth gradually shorter, ninth to eleventh equal to eighth; female with scape reaching three-fourths across eye, second segment a little more than half the length of first, remaining segments slightly shorter than second, except fourth which is as long as second, and seventh to tenth which are slightly shorter than third.

Length: 13-15 mm.

Type locality: Davis Mts., Texas.

Distribution: Known from west Texas, Arizona, and New Mexico.

Texan localities: 1; Big Bend Region. 1; Dimmit Co. 1; Weslaco. 1; Sonora. 1; Devil's River; [USNM—paratype]. 1; Cotulla; [USNM—paratype]. 2; Presidio; [USNM]. 1; Rio Grande, Brewster Co. [USNM]. 13; Glenn Spring, Brewster Co. [MU]. 12; Fort Davis; [MU—3, OU—9]. Occurs from April to August.

Remarks: Distinguished by the elongate, slender form, the body dark with ferruginous elytra, the elongate scape of the male, with the second segment only one-third its length, the large eyes, and by the single protarsal spur in the male.

EPICAUTA LINEARIS (LeConte)

Lytta linearis LeConte, Journ. Acad. Nat. Sci. Phila. (2) 4:23, 1858. *Macrobasis*

linearis (LeConte). Horn, Proc. Am. Phil. Soc. 13:94, 1873. *Epicauta linearis* (LeConte). Werner, Bull. Mus. Comp. Zool. 95:513, 1945.

Fuscous, elytra light ferruginous, legs dark ferruginous; entirely covered with pale fulvous-gray pubescence; femora and tibiae in part glabrous in male. Elytra with a very small, glabrous macula near scutellum. Femora in male fringed with long hairs.

Head four-fifths as long as wide, sides divergent to eye, median impressed line distinct; eye prominent, over twice as wide as interocular space, distinctly broader than infraocular space, and subequal to the supraocular area; antennal callosities glabrous, large, oval. Pronotum subcampanuliform, four-fifths width of head, distinctly longer than wide; disk with median impressed line fine, confined to apical half, basal impression rather narrow, distinct. Scutellum moderately narrow. Protibiae in male with a single, robust spur; mesotibial spurs long, acute, inner one longer; metatibial spurs rather short, stout, inner faces concave, outer spur shorter than inner. Protarsi in male with first segment contorted, short. Antennae attaining basal third of elytra, slightly tapering distally from fourth segment; male with scape just attaining occiput, rather slender, arcuate, somewhat flattened, strongly emarginate on apical third, second segment cylindrical, one-fifth as long as first, the third one-sixth longer than second, the fourth as long as second and third together, the fifth slightly longer, and remaining segments slightly shorter, than fourth; according to Werner in the female the scape reaches "two-thirds across eye, second segment and following as in male but not so broad towards the middle or as slender apically."

Length: 11 mm.
Type locality: Llano Estacado (Texas or New Mexico).
Distribution: Known only from west Texas.
Texan localities: 1; Presidio. 1; S.E. Hidalgo Co. [G. B. Vogt]. Occurs from May to July.

Remarks: This rare species is distinguished by the narrow form and the body coloring, and by the form of the antennal scape and the single protarsal spur of the male.

Epicauta reinhardi, new species

Light to rather dark ferruginous, rather densely covered with pale ashy pubescence. Elytra, tibiae, tarsi, and antennae piceous or fuscous, largely blackish pubescent. Elytra sparsely pale pubescent on sides and at base, more densely so on apex. Tibiae with scattered, sparse, pale setae. Antennae with pale pubescence only on extreme apex of scape. Abdominal sternites with broad bands of dark pubescence, increasing in width from first to last.

Head one-tenth wider than long, sides rounded to eyes, median sulcus entire; eyes distinctly longer than interocular width, distinctly wider than infraocular space, about two-thirds width of supraocular area; antennal callosities oval, small, each with a small fovea. Pronotum feebly longer than wide, three-fourths as wide as head, sides feebly divergent to apical third, thence rounded to apex; disk with median sulcus distinct, glabrous, entire, basal impression deep but rather small. Protibiae with anterior spur feebly shorter than posterior; metatibial spurs with inner faces concave, the outer one slight-

ly shorter and feebly stouter than inner. Antennae nearly attaining middle of elytra, slender, tapering distally from second segment; male with scape distinctly surpassing hind margin of eye; second segment slightly more than half length of scape; third and following segments as long as second, except fourth which is feebly shorter.

Length: 14 mm.
Holotype: Male; Dimmit Co. Texas, June 13, 1933.

Remarks: Somewhat intermediate between *E. sublineata* and *E. merkeliana*. From the former it differs in the pale body and in having the second and third antennal segments equal. From the latter it differs in having the elytra blackish pubescent and in the pronotum being scarcely longer than wide.

EPICAUTA TENELLA (LeConte)

Lytta tenella LeConte, Journ. Acad. Nat. Sci. Phila. (2) 4:23, 1858. *Macrobasis tenella* (LeConte). Horn, Proc. Am. Phil. Soc. 13:94, 1873; Trans. Am. Ent. Soc. 12:108, 1885. *Epicauta tenella* (LeConte). Werner, Bull. Mus. Comp. Zool. 95:493, 1945.

Orange- or red-fulvous; body beneath, pronotum in part, and entire elytra black or blackish; rather sparsely covered with short, grayish-white pubescence. Elytra each with a very small, dark, scutellar macula.

Entire upper surface rather finely punctate and minutely densely alutaceous; elytra subrugose as well. Head one-third broader than long, sides subparallel, median impressed line entire; antennal callosities narrow, rather small, glabrous; eye distinctly longer than interocular width, about as broad as infraocular area. Pronotum one-tenth longer than wide, one-fourth narrower than head, sides arcuately expanded to apical third, thence constricted to apex; median line distinct on basal two-thirds of disk, basal impression obsolete. Protibiae with two spiniform spurs in both sexes, the anterior one longer; metatibial spurs subequal in stoutness and length, both with obliquely truncate apices, the truncature ovate, acute. Antennae slender, attaining basal fourth of elytra; first segment attaining hind margin of eye in male, nearly so in female, slender; second segment three-eighths as long as first in fmale; third and following segments subequal, one-third longer than second in female.

Length: 11 mm.
Type locality: Llano Estacado.
Distribution: Arizona to Texas.
Texan localities: 1; Castolon, June 1.

Remarks: One of the few known species of *Epicauta* in which the elytra are darker than the head and pronotum. In both sexes the protibiae have two spurs and the second antennal segment is shorter than the third.

Epicauta macroflexi, new species

Elongate, slender; pale or dark fulvous, head sometimes a little darker than pronotum and elytra; fairly densely covered with short, grayish-white pubescence. Elytra with small, scutellar and humeral, dark pubescent macu-

lae. Apices of femora and often apices of abdominal sternites, most tibiae, and entire tarsi infuscate or with darker pubesecnce. Antennae largely dark pubescent, with sparse pale pubescence on apices of first and second segments.

Entire upper surface densely, rather finely punctate and densely, minutely alutaceous; the elytra subrugose as well. Head one-fourth wider than long, sides arcuately feebly divergent to eyes, median line entire, antennal callosities glabrous, elongate-ovate; eye equal to about twice interocular width, feebly broader than infraocular area. Pronotum one-sixth longer than wide, one-sixth narrower than head, campanuliform, narrowed on apical third; disk with a fine median impressed line, nearly entire, basal impression rather deep, small. Protibiae in male with a single spur, with two subequal spurs in female; metatibial spurs short, subequal in length and stoutness, inner one concave throughout most of its length, the outer one with apex strongly, obliquely truncate, the truncature elongate-ovate. Protarsi in male with first segment short, contorted. Antennae reaching nearly to middle of elytra, slender, slightly tapering apically from fourth segment; scape feebly exceeding hind margin of eye in male, reaching two-thirds across eye in female; second segment half as long as first in both sexes; third segment one-seventh shorter than second in male, one-third longer than second in female; fourth and following segments subequal, slightly longer than second in male, equal to third in female.

Length: 8-14 mm.
Holotype: Male; Big Bend Region, Texas.
Allotype: Female: Balmorhea, Texas.
Paratypes: 2; Topotypic. 3; Presidio. 1; Van Horn. 1; Sierra Blanca, El Paso Co. [AMNH]. Occurs from June to August.

Remarks: Apparently closely related to *E. arizonica* Werner, but distinguished by the much shorter antennal scape in both sexes.

EPICAUTA LAUTA (Horn)

Macrobasis lauta Horn, Trans. Am. Ent. Soc. 12:108, 1885. *Epicauta lauta* (Horn). Werner, Bull. Mus. Comp. Zool. 95:492, 1945.

Red-fulvous or ferruginous; femora apically, tibiae, tarsi, and antennae infuscate or blackish; apices of abdominal sternites often dark. Covered rather sparsely with short, fine, pale ashy-gray pubescence. Elytra with dark humeral and scutellar maculae.

Entire upper surface finely, rather densely punctate, and densely, minutely alutaceous. Head one-fourth wider than long, median line reaching to middle of front, sides broadly rounded from vertex to eyes; the latter about two and one-half times as long as interocular width, slightly broader than infraocular space but not so broad as supraocular area. Pronotum about one-tenth longer than wide, one-fifth narrower than head, sides gradually widened to apical two-fifths, thence constricted to apex; disk with median impressed line distinct except apically, at base tumid on each side, basal impression distinct. Protibiae polished behind and with a single spur in male, female with two equal spurs; metatibial spurs rather short and stout, both with apices obliquely

truncate, subconcave, elongate-ovate. Protarsi in male with first segment short, contorted. Antennae reaching to basal fifth of elytra, slender, tapering apically from fourth segment; scape slightly arcuate, slender, reaching hind margin of eye in male, about two-thirds across eye in female; second segment nearly two-thirds as long as first in male, half as long as first in female; third one-fifth shorter than second in male, one-fifth longer in female; fourth nearly as long as second in male, longer than third in female; remaining segments subequal to third in both sexes.

Length: 9-15 mm.

Type locality: Arizona.

Distribution: Occurs from west Texas and New Mexico to California.

Texan localities: 3; Presidio; [USNM]. 21; Glenn Spring, Brewster Co. [MU]. 1; Fort Davis; [MU]. 3; Sierra Blanca, El Paso Co. [MU]. Occurs from June to August.

The following species of *Epicauta* are listed by Werner as occurring in Texas, on the basis of a single record in all cases. As specimens of these were not at hand, and as an entirely different scheme of classification is employed, it was impossible to place them in the key to species or in the main body of the text. These species and their salient features are as follows:

E. andersoni Werner, Psyche 50:66, 1944; Bull. Mus. Comp. Zool. 95:444, 1945.—Practically identical with *pardalis* LeConte but the antennae are more slender, and in the male both pairs of palpi are enlarged, the labial palpi having the last segment nearly circular in outline. Listed as occurring at Childress, Texas.

E. mimetica (Horn), Trans. Amer. Ent. Soc. 5:154, 1875. Werner, Bull. Mus. Comp. Zool. 95:453, 1945.—Body entirely black or dark brown, densely clothed with deciduous brownish-cinereous pubescence. Labrum deeply incised. Mandibles elongate. Listed as occurring in the Davis Mts., Texas.

E. calcarata Werner, Psyche 50:70, 1944; Bull. Mus. Comp. Zool. 95:477, 1945.—Black, densely fulvous-gray pubescent. Mouthparts as in *mimetica* (Horn). Tibial spurs heavy and incurved. Recorded from Ft. Stockton, Texas.

E. flavocinerea (Blatchley), Col. Indiana:1359, 1910. Werner, Bull. Mus. Comp. Zool. 95:500, 1945.—Black, sparsely yellow-cinereous pubescent. Antennal scape in male extending halfway between eye and occiput, in female attaining hind margin of eye. Meso- and metafemora in male with long fringing hairs. A single example in the Fall collection is labelled "Tex.," but as otherwise this species is known only from Illinois, Indiana, Pennsylvania, and central Canada, this specimen is possibly incorrectly labelled.

Maculicauta, new genus

Elongate-ovate, comparatively robust, moderately small; pubescence bright orange, with large black maculae. Head strongly transverse, nearly two-thirds again as wide as long, vertex distinctly impressed medially, median sulcus entire; eye not so wide as interocular space, oblique. Pronotum strong-

ly transverse, wider than head, widest near base; disk impressed each side. Elytra widened apically, apices evenly rounded, not obliquely so; disk (when viewed from side) at base strongly elevated above plane of pronotum. Legs rather short, hind ones distinctly longer. Protibial spurs unmodified; metatibial spurs short, subequal in length, the outer one more robust. Antennae moderate in length, attaining basal fifth of elytra; scape reaching to middle of eye; second segment shorter, and third distinctly longer, than first in male, third slightly shorter than first in female.

Genotype: Epicauta stuarti LeConte.

Remarks: Closely related to *Epicauta* but distinguished by the form of the head, which is two-thirds wider than long, by the strongly transverse pronotum, and by the elytra being strongly elevated basally so that they are distinctly above the plane of the pronotal disk.

MACULICAUTA STUARTI (LeConte)

Epicauta stuarti LeConte, Trans. Amer. Ent. Soc. 2:54, 1868. Horn, Proc. Am. Phil. Soc. 13:101, 1873. Werner, Bull. Mus. Comp. Zool. 95:462, 1945.

Black, densely clothed with long, orange-fulvous pubescence. Head, except on front below eyes, black pubescent. Pronotum with a large, black pubescent macula each side of middle, confluent medially. Elytra with a large, common, semicircular macula occupying basal third of disk, sometimes divided along suture, and another behind middle nearly as long, ovate, black pubescent. Body beneath (except orange pubescence on apices of abdominal sternites and lateral vitta of same color on abdomen), legs in great part, and antennae, black pubescent. Profemora and protibiae fulvous pubescent on anterior faces.

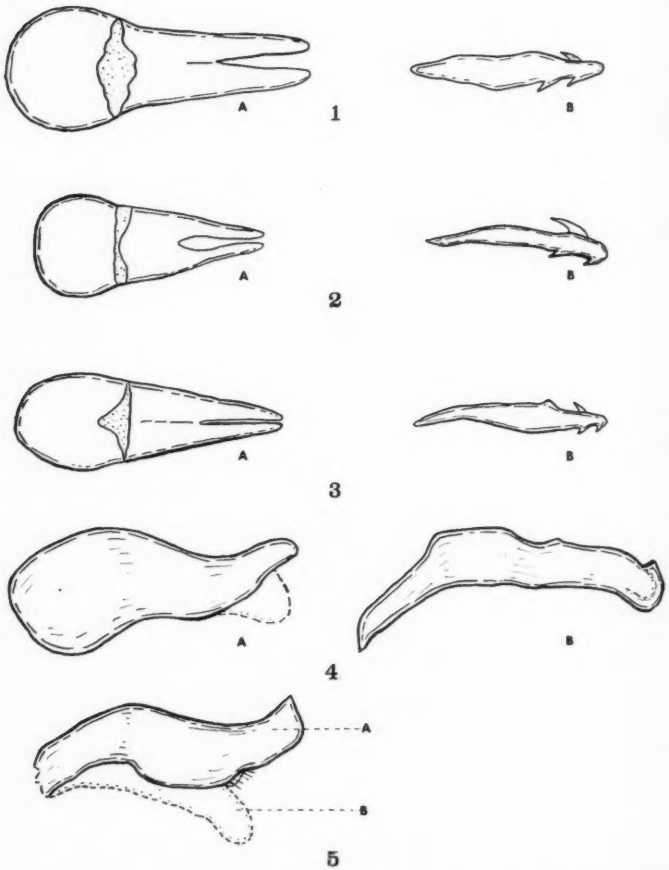
Head nearly two-thirds wider than long, arcuate from vertex to eyes, vertex distinctly impressed medially, median sulcus distinct, entire; eye about three-fourths as long as interocular space, about equal in width to both infraocular and supraocular areas. Pronotum more than one-third wider than long, wider than head, sides expanded to basal fourth, thence arcuately narrowed to apex; disk laterally somewhat tumid, with a distinct median impressed line, apically and basally in part concealed by pubescence, on each side near apical third an oblique impression and a shallow fovea each side at middle, the basal impression obsolete. Scutellum moderately wide. Protibiae with anterior spur slightly longer than posterior one; mesotibial spurs equal in length; metatibial spurs short, equal in length; the inner subconcave, the outer one much more robust. Antennae attaining basal fifth of elytra; rather slender, tapering apically; in both sexes scape reaching to middle of eye, slightly arcuate, second segment half as long as first; in male third segment a little longer and fourth slightly shorter than first, the fifth not quite so long as fourth, the remaining ones gradually shorter; in female third segment slightly shorter than first, the fourth and fifth only slightly longer than second, and the sixth and following about as long as third.

Length: 8-13 mm.
Type locality: New Mexico.
Distribution: New Mexico, Colorado, and Kansas to Texas.

Texan localities: 3; Kress. 1; Amarillo. 2; Vega. 1; Dalhart; [USNM]. Occurs in September and October.

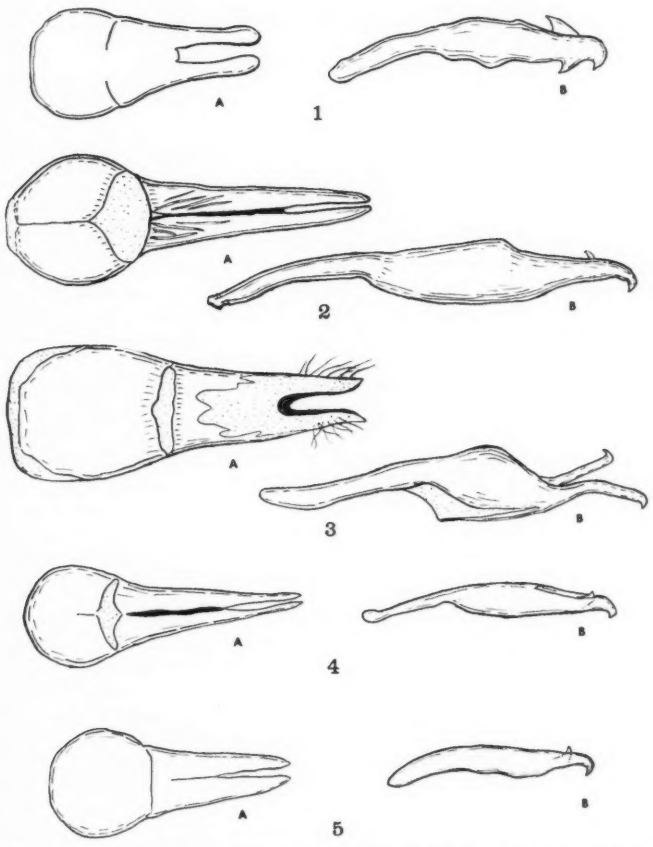
Remarks: In addition to the generic characters, this species is easily distinguished from other members of the subfamily by its unique coloration.

PLATE I



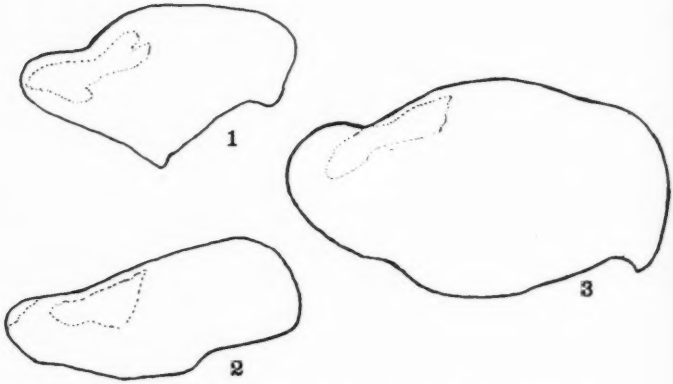
Figs. 1-5. Male genitalia.—1. *Megetra cancellata* LeConte; 2. *Pomphopoea texana* LeConte; 3. *Eupompha fissiceps* LeConte; 4. *Nemognantha lurida* LeConte; 5; *Pseudozonites roseomaculatis* n. sp. A—tegmena, B—aedeagus; stippled areas are membranous.

PLATE II



Figs. 1-5. Male genitalia.—1. *Lytta fulvipennis* LeConte; 2. *Epicauta albida* Say; 3. *E. nigritarsis* LeConte; 4. *E. lemniscata* Fabricus; 5. *Henous confertus* Say. A—tegmena, B—aedeagus; stippled areas are membranous.

PLATE III



Figs. 1-3. Terminal segment of palpi in male.—1. *Pyrota concinna* Casey; 2. *P. palpalis* Champion; 3. *P. mylabrina* Chevrolet

Immature Stages of the Marine Fly, Hypocharassus pruinosus Wh., with a Review of the Biology of Immature Dolichopodidae

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An adult female and several broken pupae of the marine dolichopodid fly, *Hypocharassus pruinosus* Wheeler, were brought to this laboratory from Cape Cod in 1945 by Dr. Charles F. Fraker of this university. In 1948, several additional pupae and the remains of their sand cocoons, two unbroken cocoons, and a single mature larva were collected on the same beach by Marc Sagan and James Baird, students in the department. In 1949 and 1950, Mrs. Frank Bryant of Weymouth, Mass., found cocoons, larvae, and pupae of this species, also on the Cape, and sent them to several museums and specialists for identification. The sand cocoons could not be identified, although Dr. William F. Clapp of Duxbury, Mass., reported finding them on the beach at Great Island, near South Yarmouth, on the Cape. It was not until after she sent larvae and pupae to the National Museum in Washington that the cases were recognized as insect structures, and determined by Dr. W. W. Wirth as cocoons of an unknown species of Dolichopodidae. Since little has been reported on the biology of this rather uncommon fly, and since relatively few insects are marine in habitat, it seems worthwhile to record the observations of these collectors, and to describe the present material.

Hypocharassus pruinosus was described by Wheeler (1898) from a single Florida specimen, under the name *Drepanomyia* Wh., which he later (1900) recognized as synonymous with *Hypocharassus* Mik, erected some twenty years earlier for a Georgia species. The fly is drab in general coloration, with the brilliant metallic luster so often seen in the Dolichopodidae overlaid with the pruinose coating which suggested its name, but both sexes possess antennae with a peculiar basal lobe on the third segment (fig. 9) by which the species is easily recognized. Snodgrass (1922) records *H. pruinosus* as from the beaches of Florida, Georgia, and North Carolina. Mr. C. F. W. Muesebeck writes that the United States National Museum has specimens from Rhode Island and Long Island as well as from the localities listed above. Wheeler (1900) makes the following notes concerning the biology of the species:

"During the past summer while collecting Diptera at Wood's Hole, Mass., I was fortunate enough to encounter both sexes of this fly in considerable numbers. . . . (It) was observed from July 21st to August 3rd. It occurred in small swarms along the shores of Buzzard's Bay between the "neck" at Wood's Hole and Quisset Harbor. The insects ran about between tides on the wet sand and over the barnacle-coated rocks or flew about in the 'thatch grass,' often in the spray of the breakers. Their flight was peculiar and unlike that of any Dolichopodid known to me, being very rapid and in straight lines for a little over a yard at a stretch. Their wings, which have the appearance of ground-glass, render them quite conspicuous, so that I could sometimes capture them on the wing. Like the species of *Hydrophorus*, they are not easily captured while running.

"It thus appears that *Hyocharessus*, as far as its habits are concerned, is to be placed with the marine Dolichopodid genera *Thinophilus, Aphrosylus, Machaerium,* and *Epithalassius*. . . . I believe that the larva of *Hypocharassus* lives in the salt water like that of *Aphrosylus*, for one of the females of *H. pruinosus* captured by me at low tide mark was still soft and had evidently just emerged from its pupa."

DR. FRAKER writes: "About 1925, I first found a specimen (fig. 1) which I thought to be the egg-case of some sea animal, on the beach at Sea Pines Camp, East Brewster, Cape Cod, Mass. It was about one-half inch long, egg-shaped, with a circular opening at the small end, made of sand and some adhesive material that is resistant to salt water. In later years I found these forms repeatedly during the summer, but could find no published description of them. They were always empty, due perhaps to exposure to sun and heat on the shore, where they had been deposited by the out-going tide.

"During the first week of August, 1945, while out on the tidal flats, I discovered several specimens with living larvae in them. The larvae were slender, with one end considerably larger than the other, and varied in length from one-half cm. to longer than the case in which they lived. They lay slightly curved within the case, with the large end, I think, near the opening in the more mature specimens. Due to the lack of a microscope, I

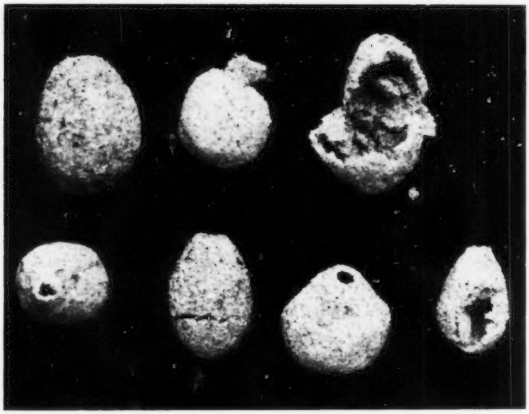


Fig. 1.—Sand cases of *Hypocharassus pruinosus*, natural size, showing lateral aspect of some and the apical opening of others.

could not make proper examination of the specimens. Others of the cases, which were always open at one end, contained living and active pupae. Although the cases disintegrated soon after exposure to the dry air, the pupae were kept moist in a bottle for later examination. One specimen, a full-grown larva when taken, pupated two days later and eventually completed its metamorphosis.

"Judging from the fact that these forms appear on the Sea Pines shore after heavy easterly winds, I suppose that they must have come from the edge of the sea meadows that lie between Brewster and Orleans. It would seem that the larvae might construct the houses as food traps similar to those of the tiger beetle, on the sandy shore, and obtain their food from the water that rushes over them at high tide. Ordinarily, the tides are very calm in these waters, flowing in over flats that extend from half a mile to two

and one half miles from the shore. In stormy weather, however, the shore sand is washed away, to be brought back with the wind shift. In 1945, the sand was carried away to a depth of three feet at some points along the Brewster shore. Under such conditions, the larval houses, which would have their openings flush with the surface of the sand, would be carried off-shore and deposited on the flats or washed up on the down-wind beaches.

"My guess is that the adult flies will be found in numbers among the grass of the sea meadows, but the eggs must be laid along the outer edge, since sand for the houses is not available in the meadows themselves, which are made up entirely of silt and humus."

MRS. BRYANT writes that she found her first specimens "during the first week of July, 1949, on Namskaket Beach, Orleans, Mass., — one of the many inside delightfully warm salt water beaches of the Cape. We had been on the beach during the incoming tide, and had returned later on the same outgoing tide for another swim. These little 'sand molds' were all over the beach (when we returned, not before)—on the sand, on the seaweeds, and washing back and forth in the water close to shore. . . . There were literally hundreds of them—one could hardly step without crushing them underneath. In spite of that, no one seemed to know what they were—the natives called them 'squid eggs.' Every one had a tiny living larva inside."

Again in 1950, in the first week of July, she found the cocoons on the same beach, everywhere she walked—but on one day only, though she watched throughout the month. All were below the high tide line, so far as she noted, in plain sight on the beach and on washed-in seaweeds still wet from the tide. She wonders whether they were made in the water and washed in, or on the shore in that short time of an hour or more on the receding tide, and whether, had it not been a very calm tide, they would all have been crushed by the waves, so that none would have been seen.

Sagan and Baird also found their specimens, of which there were many, on sand bars at low tide on a Brewster beach (adjoining Orleans), on July 8.

Intrigued by these observations, and anxious to learn something more of the biology of this insect, the writer spent the first week of July, 1951, on Cape Cod, in Brewster and Orleans, visiting Namskaket Beach sometimes twice daily. The adult flies were abundant on "Skaket" from June 30 through July 8; from their numbers they must have appeared well before the first of July, and undoubtedly occur throughout most of the summer since Wheeler collected them through August 3rd. At low tide they frequented the wet sand, running swiftly for short distances, and then half flying, half leaping, to alight a few inches away, but always so close to the ground, and so alert, that one frequently collected a net full of sand, but seldom the specimen itself. They were equally abundant on the exposed sand bars half a mile from shore, and in the sandy beds of salt marsh grass which border the bathing beach and fringe this section of Cape Cod Bay. The flies were not observed to feed on the sciarids and smaller dolichopodids which occurred with them in the grass, but out on the open sand flats they frequently paused to probe small depressions with their mouthparts, as if feeding on minute Crustacea or other marine life left by the receding waters. Occasional encounters with other flies, during which copulation may have occurred, were observed, but there was apparently no oviposition.

A few of the flies were seen on a sandy Hyannis beach near the Nantucket boat dock on July 5; and on the same day, at Point of Rocks, Brewster, such great swarms of the flies occurred on the wet seaweed washed in by a storm that it was possible to capture a number of them. Here the swallows were feeding, skimming so low over the beach that their wings seemed to touch the sand, and flying off with beaks filled with flies.

The sand cocoons were found on this Brewster beach in small numbers on the same day. At "Skaket," a few of the cocoons were found nearly every day during the week, lying on the wet sand at low tide. However, it was not until after a heavy wind storm from the west on the night of July 5, and throughout the next day, a storm that churned the normally quiet waters of the Bay into a white-capped sea, sent waves pounding upon the little beach, and whipped the dry sand into a driving sheet, that the cocoons were found in abundance. Then, on the morning of July 6, following an unusually high tide, great numbers of the cocoons were found on the wet sand, some very close to shore, others on the outer sand bars, still others tangled up in masses of sea grass driven in by the storm. The force of the wind was so great that a cocoon loose upon the wet sand would roll shoreward with great speed, until caught in a ripple-mark that afforded some resistance. Several of the cocoons, with pupae inside, were found far up on the dry beach, driven there by the wind. The afternoon low tide found still others stranded upon the sand of the beach, or tumbling about in the edges of the outgoing waves. In about a half hour that day, 130 cocoons were picked up. Of these, 70 were empty, the adult flies presumably having emerged during low tide; three others contained larvae, two held cast pupal skins, and the other 55 contained pupae of varying ages. Many others were seen but not collected.

All of the cocoons found in the water, lying in shallow pools on the sand bars, or actually floating or tumbling about in the waves, were air-filled, so that even if completely submerged at high tide, the insect is provided with atmospheric oxygen. When not submerged, the pupa, although much shorter than its cocoon, often lies with its respiratory horns protruding through the opening in the case. A few well-developed pupae, placed upon moist sand, yielded adults within a few days, the pupa crawling partially or completely out of its cocoon before emergence of the adult. Other cocoons containing less-advanced pupae were carried back to Amherst on moist sand, moist paper, or dry, as if washed above the tidal zone; in most cases the pupa soon crawled out of its case and lay exposed, though active. Pupal development continued until all imaginal structures were distinctly visible, but conditions clearly were not satisfactory for the emergence of the adult, and all turned black and soon shrivelled. Pupae submerged in salt water overnight lost all signs of activity, although the internal development of some continued for a few days. On July 7, three larvae were collected in their cases: two of these were removed and placed on wet sand, but they made no attempt to attack each other or to construct new cases. All three pupated on July 9; by July 18, two of them, still active, showed complete development of the imago, but again none

emerged. A period of about ten days, under these unfavorable conditions, would thus be indicated for the pupal stage.

Considerable digging and sifting of sand on the sand flats, in the sea meadows, and beneath masses of washed-in seaweeds, and careful searching among the seaweeds on rocks submerged at low tide failed to reveal the breeding places of the larvae, or any of the cocoons in their normal location before being unearthed by wind and waves. It may be that the great majority of the early brood of flies had emerged, since so few larvae were found, and these were ready to pupate. The possibility of more than one annual generation cannot be overlooked, for Fraker's casual observations indicated larvae of various sizes, and larvae and cocoons occurring during August. A search prior to early July, or considerably later in the summer, might well yield more information concerning larval breeding places, feeding habits, and cocoon construction.

It seems unlikely that the larvae feed and construct their cases in the sea meadows, since the superficial layer of sand over the silt and humus is not as deep as the case itself; it is only on the open beach and on the sand flats that the sand is of the same color and consistency as that of the cocoons, and of sufficient depth to allow construction of the case so that its opening lies flush with the surface. The writer is convinced that here, either in the areas exposed at low tide and packed hard by the waves, or in those lower areas where water always stands, giving refuge to stranded marine life, the larvae develop and build their cases, either as larval houses or as shelters for the pupal stage. Since other dolichopodid larvae are predaceous in habit, it is probable that the larva is associated with other marine life of the flats—with the clams, hermit crabs, snails, and small Crustacea that are so abundant, the marine plankton invisible to the naked eye, or with the annelid worms whose sand-tubes are interlaced throughout extensive areas. Whatever the breeding place and feeding habits of the larva of this insect prove to be, it is one of the few truly marine insects, and as such, a more complete understanding of its biology and life habits is certainly to be desired.

DESCRIPTIONS OF THE IMMATURE STAGES

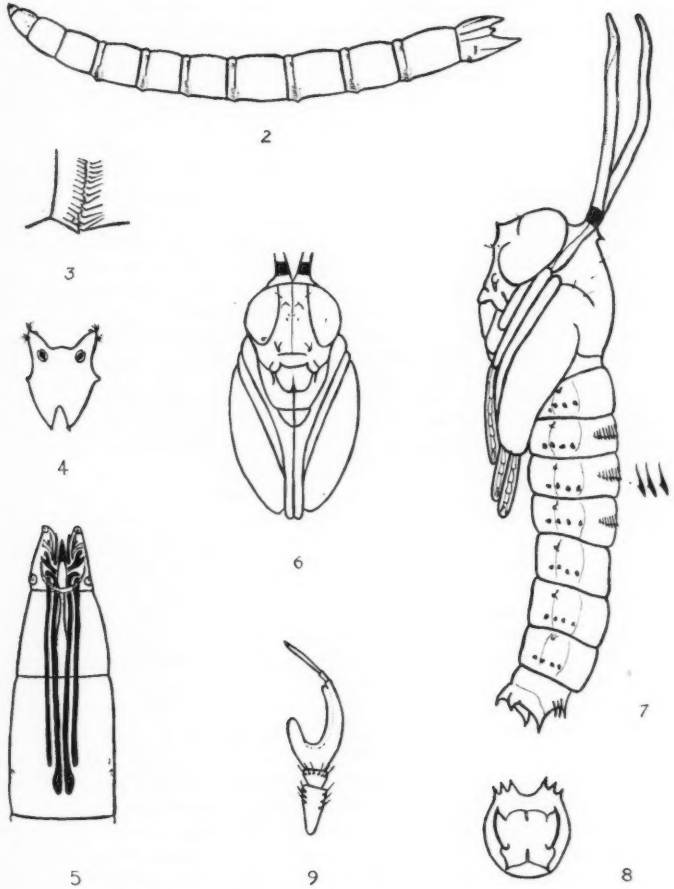
Few North American species of Dolichopodidae are known in their immature stages. The most complete larval description is that given by De Leon (1935) for *Medetera aldrichii* Wh.; a briefer pupal description is included. The larva and pupa of *M. caerulescens* Mall. have been briefly described by Malloch (1919); those of *Hydrophorus agalma* Wh. have been described and figured by Green (1923); of *Argyra albicans* Lw. by Marchand (1918); of *Thrypticus muhlenbergiae* Joh. & Cr. by Johannsen and Crosby (1913); and of *Aphrosylus praedator* Wh. by Wheeler (1897) and Saunders (1928). Peterson (1951) describes and figures the larva of *Dolichopus ramifer* Lw. Some excellent observations on the biology of several species of Hawaiian Dolichopodidae are recorded by Williams (1933, 1938, 1939), who describes and figures larvae and pupae of five genera, of which *Campsicnemus* and

Hydrophorus occur in North America. In general, European species are better known; Lundbeck (1912) discusses the family characters, and describes the larvae and pupae of twelve genera, eight of them occurring in this country.

Larva (Figs. 2-5).—The larva of *Hypocharassus* agrees with other dolichopodid larvae in being smooth, cylindrical, tapered at the anterior end and truncate posteriorly; the abdominal segments with ventral ambulatory welts which are provided with minute blunt colorless spinules, whose nature and arrangement furnish important taxonomic characters for the group; the posterior spiracles exposed, on the swollen and longitudinally furrowed caudal segment, the spiracles surrounded by four or more fleshy lobes (in a few genera these are scarcely distinct); and the head retractile, with a triangular dorsal plate and long metacephalic and tentorial rods which extend back into the prothorax. The following description is based upon several mature specimens and a number of cast skins:

Length 16-17 mm.; width 1.5 mm. White, except for mouthparts and spiracles; smooth except as indicated, shining, not striated. Head small, subdivided, with long slender black metacephalic and tentorial rods (fig. 5) extending almost to the mesothorax; antennae and maxillary palpi reduced to minute papillae; mouthparts as shown. Body 11-segmented; cylindrical, anterior end gradually tapered, posterior end blunt. Abdominal segments one to seven each with a narrow apical ring, distinctly separated dorsally from remainder of segment, and projecting ventrally as an ambulatory welt or pseudopod. Each welt provided with blunt posteriorly projecting spinules (fig. 3), finely serrated at their tips, concolorous with the rest of the cuticula and arranged as follows: on segments two to seven, 10-12 on each side of the mid-ventral line, with a narrow but distinct space between the two groups; on the first segment, about 7 on each side; dorsally, on segments one to seven, two blunter more lobe-like spinules on each side of the mid-dorsal line; each row of ventral spinules followed by a row of low knobbed longitudinal carinae. Ninth segment somewhat bulbous, furrowed so as to divide the segment into several longitudinal sections: 1 mid-dorsal, 2 mid-ventral, and on each side, 3 laterals. Anal opening a longitudinal slit on ventral surface of ninth segment, preceded by several small locomotor spinules. Prothoracic spiracle minute; spiracular plate of 9th segment (fig. 4) bordered by fleshy inwardly-projecting lobes, capable of enclosing the respiratory pit, and arranged as follows: two dorsal lobes, slightly separated; two ventral lobes, considerably longer and contiguous mid-ventrally, and a very short lateral lobe on each side; spiracles, black-centered and separated by twice their own diameter, at bases of dorsal lobes.

Cocoon (fig. 1).—Length 12-20 mm.; width 9-15 mm.; averaging 16-18 mm. long by 12 or 13 mm. wide, varying considerably in size, shape, and proportions; with an opening at one end 2-3 mm. in diameter. All contained pupae, full-grown larvae, or were empty; cases containing half-grown larvae, if they occur, were not seen by the writer. Shape generally a definite ovoid, with the opening at the smaller end, but often more uniformly elliptical, or



Figs. 2-9.—2. Lateral view of larva. 3. Ventral locomotor spinules of larva, lateral view. 4. Spiracular plate of larva. 5. Dorsal view of head and prothorax of larva, showing internal mouthparts. 6. Ventral view of head and thorax of pupa. 7. Lateral view of pupa. 8. Caudal end of abdomen of pupa. 9. Inner aspect of antenna of adult fly.

the smaller end sharply tapered, or asymmetrical. Constructed of fine sand grains, several layers thick, fastened together with a transparent substance, the mouth of the opening and the inner surface smoother than the outer; very fragile in structure, completely and quickly disintegrating with rough handling, but able to withstand protracted wave action, and preserving well in alcohol, or dry if protected.

Pupa (figs. 6-8).—The pupa of *Hypocharassus* agrees with other described pupae of Dolichopodidae in possessing elongated respiratory horns, sharp frontal tubercles, tarsi surpassing the wingpads in length, and dorsal abdominal locomotor spines. The nature and arrangement of the locomotor spines give indication of being important generic characters, as do the length and structure of the respiratory horns. *Hypocharassus* can be distinguished from all other known American dolichopodid pupae by the presence of single bands of locomotor spines on only three of the abdominal segments. The following description is based upon numerous specimens.

Length, exclusive of respiratory horns, 6-9 mm.; width 2-2.5 mm.; length of respiratory horns 2.3-3 mm. Color pale, sutures, tubercles, eyes, and spines dark in older pupae. Cylindrical, smooth except as indicated below. Frontal region of face swollen, with two prominent black-tipped tubercles in the antennal area; below each, a minute black tubercle, with a pair of minute setae between them; another seta dorsad of upper tubercles at edge of compound eye. Antennal sheaths consist of a pair of free two-segmented finger-like lobes above the clypeal region; each lobe represents the tip of the two-segmented arista, the rest of the antennal sheath being undifferentiated except for the frontal spines. Prothoracic respiratory horns conspicuous, as long as the wingpads, slender, non-segmented, gradually tapered and slightly sinuous, the two horns contiguous mid-dorsally; the external edge of apical half of each horn with a row of minute respiratory pores, the row recurved at the tip for a short distance to form an open loop; horns pale, the majority with a black sub-basal ring as long as its diameter, one specimen with base entirely dark instead of ringed, another with a dusky tip in addition to basal rings, and another with apical fifth black and without a basal ring; at the base of each horn is a pale swollen dorsal tubercle tipped with a minute black spine. Thoracic dorsum swollen, with four minute setae; two others above each wingpad, the anterior one usually inconspicuous. Wingpads reach nearly to 3rd abdominal segment; all tarsi surpass them, fore tarsi slightly so, middle tarsi to 3rd or 4th segment, hind tarsi to 4th or 5th, or beyond if the abdomen is strongly arched. Abdomen more or less curved, tapering slightly posteriorly, consisting of nine segments. Dorsally on segments 2, 3, and 4 there is a transverse row of heavy closely-set black-tipped spines; these rows are broken mid-dorsally, with 9-12 spines on each side, those nearest the meson considerably longer than the lateral ones. Pleural regions swollen, with minute tubercles; spiracles, on small tubercles on segments 1-6, inconspicuous and possibly non-functional on 7th. Eighth and 9th segments (fig. 8) partially fused; 8th segment with 2-5 sharp spines, often unequally developed, on each side of the

mid-dorsal line; 9th segment with 2 dorsal and 2 smaller ventral spine-tipped lobes. Sexes externally similar.

A REVIEW OF THE BIOLOGY OF THE IMMATURE DOLICHOPODIDAE

Habitats of the immature stages.—As Wheeler suggests, the marine habitat of *Hypocharassus* is a not unusual one for the Dolichopodidae. Larvae of the Pacific coast *Aphrosylus praedator* occur in the matting of filamentous algae covering rocks. Williams (1939) found larvae of *Cymatopus acrosticalis* Parent in Hawaii in "a very shallow detached splash pool lined with felt-like algal mud, in the upper tidal zone of rock with tiny pockets of mud and algae, and more rarely within the zone of green algae." Walker (1874) records the finding of cocoons of *Machaerium maritimae* Hal. on the sand of a beach in England. *Asyndetus carcinophilus* Parent occurs under decaying vegetation on sandy beaches in Hawaii, and a European *Hygroceleuthus* beneath decaying seaweed. Adults of other species of Dolichopodidae frequent salt water, and their larvae, when found, may likewise be marine in habitat.

Fresh-water habitats are characteristic of many other aquatic or semi-aquatic Dolichopodidae. The larva of *Argyra albicans* has been found in mud at the edge of a pond; that of *Hydrophorus agalma* in water only a few inches deep; and the larva of the Hawaiian *Hydrophorus pacificus* V.D. in muck containing filamentous green algae from a brackish marsh. *Eurynogaster* larvae were found in Hawaii in a wet rock bank near a spring, in accumulations of diatoms and other fine plant life, or more often among the roots of mosses and other plants which were "firmly pressed against the rocky substratum, and over or alongside which a sheet of water flowed, or that were merely water-soaked." Needham (1908) reports taking an adult *Dolichopus scoparius* from a tent-trap over a brook in the Adirondacks. Hart (1895) describes a larva which was taken from decaying and water-soaked stems of rushes floating in water, and another from mud at the bottom of a river; Malloch (1917) refers these specimens to *Dolichopus*. In Europe, *Leucostola* has been reared from sandy muck at the edge of a stream, *Porphyrops* from sand at the edge of a pond, and a species of *Hercostomus* from wet moss.

Moist soil, decomposing wood, decaying vegetation, the stems of plants, and the burrows of bark beetles are utilized by other species of dolichopodids as breeding places. A species of *Dolichopus* has been reared by Johannsen (1935) from rich garden soil, another by Brauer from decomposing wood taken from inside a hollow tree, and *D. cuprinus* from old hickory logs (Blackman and Stage). European species of *Sciapus* and *Neurigona* have been bred from beech humus, and a European *Systenus* from beech fungus, rotten wood, and exuding sap (Verrall). Peterson reared *Dolichopus ramifer* from decaying vegetation; *Campsicnemus* and *Asyndetus* have been recorded from decaying vegetation in Hawaii. Species of *Thrypticus* are stem-borers, and larvae of *Medetera* occur under bark and in the burrows of wood-boring beetles.

Food habits of the larvae.—The larva of *Hypocharassus* is presumably predaceous, as are most of the other Dolichopodidae whose food habits are

known. The Hawaiian *Campsicnemus fumipennis* and *Asyndetus carcinophilus*, for instance, have been reared on Drosophila larvae, the first in decaying banana stems, the latter in decaying guava, while the aquatic *Eurynogaster minor* fed on larvae of mosquitoes and small midges, and those of *Hydrophorus pacificus* on bloodworms and psychodid larvae. The larva of *Medetera aldrichii* Wh. is considered to be an important predator of certain western bark beetles, and similar habits have been observed for other members of the genus. Larvae of *Medetera* have been found in considerable numbers in Amherst, Mass., under the bark of red pine and in the burrows of scolytid beetles. These specimens, reared in Petri dishes, fed readily upon *Drosophila* larvae; one larva was observed to feed continuously for 10 minutes, and another for 28 minutes. They also attacked their own kind, as was evident from a rapid decrease in numbers of larvae if they were not isolated, as well as other dipterous larvae occurring with them. As De Leon noted, they seemed to find food by chance contact, often passing within 1/8 of an inch without touching it. Except for dead, slightly decaying specimens, penetration of the integument was slow and apparently rather difficult; a living *Drosophila* larva once having been stabbed, both host and victim often engaged in active struggle, with the *Medetera* larva usually successful in maintaining its hold despite the violent thrashings of its prey.

In marked contrast with such larvae which frequent vegetation, but are actually predators upon phytophagous dipterous larvae found in the same habitat, are those of the genus *Thrypticus*, whose known American and European species are borers in the stems of plants. Although they may eventually be shown to be predaceous upon other larvae or each other, at present they are thought to be truly phytophagous in their habits.

Formation of the cocoon.—Pupation within a cocoon is typical of the Dolichopodidae, although none is mentioned for the stem-mining *Thrypticus*. The fresh-water *Hydrophorus agalma*, as well as the marine *Asyndetus carcinophilus* of Hawaii, makes cocoons of sand grains held together by a transparent gelatinous substance, apparently much like the case of *Hypocharassus*; the sand cocoon of the European *Tachytrechus* is most probably quite similar. The cocoons of the fresh-water *Argyra albicans*, *Hydrophorus pacificus* of Hawaii, and the marine *Machaerium maritimae* of Europe are of fine mud with smooth inner walls, while the Hawaiian *Eurynogaster* cocoons are formed of bits of debris glued together. *Aphrosylus* spins a rounded elliptical cocoon loosely in algae above the low tide mark; emergence must take place, as with *Hypocharassus*, when the tide is low, as exuviae were noted as abundant on the exposed algae. Empty pupal cases of *Cymatopus acrosticalis* of Hawaii were also exposed at low tide, or found in splash pools.

Concerning *Medetera*, De Leon writes: "Before pupation the larvae usually construct small cells composed of frass and shreds of cambium, and line the inside with a silk-like substance. A small opening in the cocoons is generally present at the anterior end. Though the cells are not always formed, the larvae always enclose themselves in the silk-like cocoons. Within the cocoons, the larvae assume a J-shaped position, and remain thus for pupation." The

curved position of the larva within the cocoon has also been noted for *Hydrophorus agalma*, as well as for *Hypocharassus*, the cocoon being considerably shorter than the full-grown larva. Specimens of *Medetera* reared in Amherst spun very tough silken cocoons between fragments of moist blotting paper within which they tunneled as larvae.

The cocoons of *Medetera*, *Aphrosylus*, and *Hypocharassus* are provided with a small opening at one end, through which the pupal respiratory horns sometimes protrude. Of the *Medetera* cocoons observed in the laboratory, only one showed protruding respiratory horns; if poked, these were withdrawn into the cocoon as the pupa wriggled violently. In *Medetera*, as well as in *Hypocharassus*, where protruding horns were of frequent occurrence, the cocoons were always longer than the pupa including its horns, so that their protrusion was a matter of choice on the part of the pupa, which was, in *Hypocharassus*, extraordinarily active, "crawling" readily from place to place. In certain other genera, horns are said to project through the cocoon, though no definite or permanent opening is described.

The opening in the *Hypocharassus* cocoon is sufficiently large to permit the escape of the adult fly; in *Medetera*, however, it is minute, and presumably serves chiefly for the respiration of the pupa. In *Argyra* the adult emerges through a circular hole cut at the top of the cocoon, the pupal case protruding from the hole almost its entire length. Williams (1938) writes that the pupa of *Asyndetus*, which is "armed with a sharp cocoon-piercing head process, forces its way wholly or in part out of the cocoon by movements of its spiny abdominal segments. . . ." It thus appears that the heavy frontal spines or tubercles, and the abdominal locomotor spines, which are characteristic of the pupae of this family, play an important role in the emergence of the insect from its cocoon, the frontal tubercules in cutting an opening or enlarging a smaller one in the cocoon, the abdominal spines in enabling the pupa to work its way out of the cocoon before the imago emerges.

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Studies of the Biology of the Cyprinid Fishes of the Chub Genus Nocomis of Northeastern United States

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The life histories of only a few North American Cyprinidae are well understood. Although their economic importance as food or game fishes is of little value, many do serve as important forage fishes and others are used as bait by sportsmen seeking game fishes. Certain species exhibit interesting breeding behavior patterns and interrelationships and provide much scientific interest. The many species vary in distribution, growth, food habits, and mode of reproduction. Pertinent knowledge acquired from life history studies leads to intelligent management of populations of forage fishes and their effective utilization and maintenance.

This study concerns three species of *Nocomis* found in the waters of northeastern United States, namely the hornyhead chub, *Nocomis biguttatus* (Kirtland), the river chub, *N. micropogon* (Cope), and the eastern Piedmont chub, *N. leptocephalus* (Girard). The salient characters differentiating these species have been presented by Lachner (1946).

Distribution

The chubs are widely distributed over eastern United States, extending from tributaries of the Missouri and Mississippi Rivers eastward. Their local distribution and abundance vary considerably with factors of stream ecology, habitat preference, and physiography. The following important literature discusses their distribution and distributional relationships with other species: Cope (1871), Jordan (1877, 1889), Jordan and Brayton (1878), Woolman (1892), Smith (1907), Hubbs (1926), Hubbs and Ortenburger (1929), Greene (1935), Raney (1938), Greeley (1935, 1940), Hubbs and Lagler (1947), Eddy and Surber (1943), and Fowler (1945).

The distribution of *micropogon* overlaps that of *biguttatus;* the former occurs on the Atlantic slope and is absent west of the Mississippi River whereas the latter is absent on the Atlantic slope and occurs west of the Mississippi River. *Nocomis biguttatus* has its western limits from northern Arkansas and northeastern Oklahoma, northwest to Colorado and Wyoming and to eastern North Dakota, including the Red River (Hubbs and Lagler: 1947), eastward to the western portion of the Lake Ontario basin (Greeley: 1940), the Hudson River drainage of New York (Greeley: 1935), and the northern part of the Ohio River system. It occurs in the Great Lakes region, north to the Lake Superior and Green Bay drainages of Wisconsin and to the Strait of Mackinac.

Nocomis micropogon ranges from the Wabash River system and the Lower Peninsula of Michigan to the Lake Ontario basin west of Rochester, southward

on the Atlantic slope from the Susquehanna River system in New York to the James River system in Virginia, in the upper James River system of western Virginia (Burton and Odum, 1945) and on the uplands of the western Appalachian slope to the Tennessee River tributaries of Georgia and Alabama (Hubbs and Lagler, 1947).

Nocomis leptocephalus occurs on the Atlantic slope from the York River, Virginia, southward to the Savannah River drainage[1] and is found in the upper New River system of western Virginia (Burton and Odum, 1945).

In Wisconsin *biguttatus* shows an avoidance of streams and rivers underlaid by sandstone (Greene, 1935: 75). Hubbs and Lagler (1947: 63) mention that it generally avoids unglaciated uplands, and it was noted to be abundant in the more recently glaciated areas of Illinois (Forbes and Richardson, 1920: 169).

ABUNDANCE

The three species of chubs are common cyprinids throughout their ranges. In certain streams of the Lake Ontario drainage where *micropogon*, *biguttatus*, and the central common shiner, *Notropis cornutus chrysocephalus* occur together, they form the major portion of the fish fauna. In streams tributary to the Susquehanna River in central Pennsylvania *micropogon* is frequently associated with the eastern common shiner, *Notropis cornutus cornutus*, and the fallfish, *Semotilus corporalis*, where all three are abundant species. The abundance of the chubs in Indiana particularly commended their importance as bait (Evermann and Clark, 1920: 364). Their common occurrence was reported by Smith (1907: 104); Forbes and Richardson (1920: 169); Greeley (1927, 1940); and Thompson and Hunt (1930: 49). *N. biguttatus* is not common in the Ohio drainage basin of western Pennsylvania. Hubbs and Cooper (1936: 47) remark that in Michigan the hornyhead chub "is seldom very abundant locally." *N. leptocephalus* is common in the sandy streams of the Piedmont, this noted especially in Virgina and North Carolina.

HABITAT

The habitats of these chubs vary somewhat throughout their ranges, but certain preferences were observed. *N. micropogon* is usually found in larger streams and rivers where the water is clean and clear and where the bottom composition varies from sand and gravel to rubble. It usually avoids waters with plant growth, but does occur abundantly in certain streams of the Lake Ontario drainage of New York where algae and vascular plants abound. Smith and Bean (1899: 183) also report it as common over grassy bottoms of the Potomac River. The young and juveniles are often taken in faster moving waters and are frequently caught with other riffle inhabiting species (Raney, 1941: 3). The larger adults are often caught from deep river holes by rod fishermen. *N. micropogon's* preference for rivers has also been

1 This is a tentative distribution. The systematics of the genus are now being studied by the writer. *Nocomis bellicus* (Girard) is recognized as ranging from the Savannah River, Georgia, westward through Alabama in rivers of the Gulf drainage.

reported by Stewart (1935), Hubbs and Cooper (1936), and Hubbs and Lagler (1947). *N. biguttatus* is generally found in smaller streams and tributaries having clear water of moderate flow and some plant growth. It is reported uncommon in streams and rivers containing shifting sand and silt (Greene, 1935: 75). The young are frequently found in the algal and vascular plant beds in water with little or no current. It is probably this species which Forbes and Richardson (1920: 169) report as occurring in the glacial lakes of northeastern Illinois. It has been taken in Duck Lake, Seneca River system, New York, but its presence there was probably caused by dispersal as bait by fishermen. Smith's statement (1907: 104) that *leptocephalus* shows a preference for larger streams and avoids smaller brooks is not in accord with my observations of this species. It was often seined in tributaries of the rivers of the Piedmont during latter March and April of 1940, 1941, during June of 1946 and September of 1947.

REPRODUCTION

Spawning habits.—An interesting part of the life history of the chubs is their nest building activities. Remarkable large dome-shaped stone nests are constructed by the male, generally during latter April to June. Sometimes 10,000 pebbles may be in a single nest. An excellent account of the nest building activities and breeding habits of *micropogon* was presented by Reighard (1943) and of *biguttatus* by Hankinson (1920, 1932). Raney (1947) reported nests of *leptocephalus*. These activities have also been reported by Evermann and Clark (1920) and Greeley (1929), and parallel the breeding habits of such other cyprinids as *Semotilus atromaculatus* (Reighard, 1910; Greeley, 1930), *Exoglossum* (Van Duzer, 1933), *Parexoglossum* (Raney, 1939), and *Semotilus corporalis* (Kendall and Goldsborough, 1908). A nest of *biguttatus* is figured by Hankinson (1920: pl. 4, fig. 2) and of *micropogon* by Raney (1940b: 130).

In clear water streams with clean gravel bottoms and an abundant population of *Nocomis* it is possible to count several hundred nests in less than a mile section. When spawning, a female deposits her egg complement among the pebbles of a nest. The eggs are provided some protection from predatory fish by falling among the pebbles. A single female probably does not deposit more than 1,000 eggs. The egg complements of several adults of each species were counted. The total egg complement, right and left ovaries, in *biguttatus* ranged from 460 to 725 eggs in 4 females 80 to 89 mm. in standard length. Egg counts of 4 *micropogon* specimens, 92 to 100 mm. in standard length, ranged from 400 to 625 eggs and in *leptocephalus* from 710 to 800 eggs, based on 4 females 82 to 92 mm. (all measurements of body length below refer to the standard length unless indicated otherwise).

Nest associates and interrelationships.—The utilization of the nests of *micropogon, biguttatus,* and *leptocephalus* by other cyprinids for breeding purposes is of ecological interest and may be economically important in the maintenance of a large supply of forage minnows. These activities have been reported by Cope (1869: 209), Hankinson (1920: 8 and 1932: 317), Greeley

(1929: 172), Raney (1940a: 6, 1940b: 128, 1940c: 363, 1947: 126) and Reighard (1943: 417).

Cyprinids like the shiners, *Notropis c. cornutus* (Mitchill), and also the subspecies *c. frontalis* and *c. chrysocephalus*, the rosyface shiner, *Notropis rubellus* (Agassiz), the southern redbelly dace, *Chrosomus erythrogaster* (Rafinesque), the eastern redbelly dace, *Chrosomus oreas* Cope, the central stoneroller, *Campostoma anomalum pullum* (Agassiz), the blackside darter, *Hadropterus maculatus* (Girard), the rosyside dace, *Clinostomus vandoisulus* (Valenciennes), *Notropis ardens ardens* (Cope) and *Notropis cerasinus* (Cope) have been known to spawn or perform breeding activities over these nests. The usual group of egg predators, including the bluntnose minnow, *Hybrohynchus notatus* (Rafinesque), the hog sucker, *Hypentelium nigricans* (Le Sueur), percid fishes as *Boleosoma n. nigrum* (Rafinesque), *Etheostoma b. blennoides* Rafinesque, and *Poecilichthys caeruleus* (Storer) and juvenile *Nocomis* are also about the nest. This close association of certain species during the breeding season develops antagonisms and also, in some cases, probably more intimate relationships among the adults. Hankinson (1932: 418) remarks on the possible commensalism of *biguttatus* and the central common shiner. The former species built the nest while the latter chased away intruders. An exception to these habits was observed in Sandy Creek, New York, on April 25, 1946, by myself where a hornyhead chub was quite persistent in driving away male common shiners of equal size from the nest. Of this close association between these two species Thompson (1929: 5) and Thompson and Hunt (1930: 66-69) further remark of "its extreme exactness," the "two species being found together in 99 percent of the collections in which either one of them occurred." These ecological data may be of value in introducing or managing a forage population.

As result of the confined spawning area over the nests, there is a greater possibility of hybridization among the breeding associates and between these species and *Nocomis*. Reighard (1943: 422) postulates certain probable reciprocal crosses among certain spawning associates. Interesting hybrids between *Rhinichthys cartaractae* × *Nocomis micropogon* (Raney, 1940d), *Nocomis leptocephalus* × *Campostoma anomalum* (Raney, 1947: 129) and *Notropis cornutus* × *Nocomis micropogon* (Greeley, 1938: 51) have been reported. In tributaries of the Susquehanna River in central Pennsylvania, hybrid *Notropis c. cornutus* × *Notropis rubellus* were frequently taken. These hybrids are usually taken where micropogon is abundant. Undoubtedly, many hybrids result from the close spawning association over the large nests of the chubs.

Age and size at maturity.—All three species of *Nocomis* are mature, and probably spawn, when three years old. The faster growing individuals of both sexes of *biguttatus* are mature when two years old. Ripe specimens of both sexes of *biguttatus* and *micropogon* were taken together on April 25, 1946, from Sandy Creek, Monroe County, New York. In a sample of 75 specimens, the largest male *biguttatus* was a ripe specimen just two years old, 119 mm. in length. It was working over a nest when caught, and was highly tuberculate, with the breeding coloration completely developed. Ripe female *biguttatus*

were also two years of age and ranged in size from 88 to 89 mm. in length. No specimens, aged three years or older, of either sex of *biguttatus* were taken, although an effort was made to collect the adults over and about their nests. Approximately 100 nests were observed on this day in various stages of completion. Also taken with *biguttatus* were several male *micropogon* specimens, two years old and ranging from 120 to 130 mm. in length, that exuded milt upon lightly squeezing the abdomen. The head tubercles and breeding colors were only slightly developed. All mature male *micropogon* examined from other localities were three years of age and were 130 mm. in length or greater. *N. leptocephalus* is also mature when three years of age. Highly tuberculate mature males were examined and were 115 mm. in length. The males of all three species mature at a greater length than their respective females.

Sexual dimorphism.—Sexual dimorphism is very pronounced among the species of *Nocomis*. This is also the case in other nest building or territory guarding cyprinids such as *Semotilus atromaculatus, Semotilus corporalis, Notropis cornutus, Notropis cerasinus, Notropis a. ardens, Campostoma, Exoglossum,* and *Chrosomus oreas*. The breeding males of *Nocomis* have well developed head tubercles. These have also been observed in females of the three species of chubs but are never well developed and appear only as white spots in the epidermis. Small tubercles are also found on the outer portions of the first 5 to 6 pectoral fin rays in the males. The function of these tubercles, as in other cyprinids, is probably largely associated as an aid in guarding the nest and for holding the female during the spawning act (Reighard, 1903, 1943; Raney, 1940a). Large swellings are developed on the occipital and interorbital areas of breeding males of *micropogon* and *leptocephalus* but do not develop on *biguttatus*. These swellings are usually more pronounced in older breeding males and greatly alter the contour of the head when compared to a mature female or immature male. Good illustrations of breeding males were presented by Greeley (1934; pl. 6), Hubbs (1926; pl. 1, figs. 1-3; pl. 2, figs. 1-3) and Hubbs and Lagler (1947; figs. 121 and 122). *N. micropogon* is figured with other tuberculate fresh-water fishes by Fowler (1912: 471, figs. 1-21).

The males develop brilliant breeding colors on the body, head, and fins. These outstanding colors do not appear in the females. The breeding coloration has been described in part by Fowler (1909: 551), Forbes and Richardson (1920: 168) and Reighard (1943: 400). The general coloration of the non-breeding adults of the three species is nearly similar. The body is olivaceous above the lateral line and a dull gray-white below the lateral line area to the belly. Some tints of brown have been observed on the dorsal parts of *leptocephalus* (Fowler: 1945, 342), and the lower parts of the body may, at times, have a coppery or violaceous hue. The heads are generally olive green above, and whitish below a line from the eye to the lower jaw. A dark lateral band extends from the snout through the eye, along the mid-side of the body, to the mid-base of the caudal fin. This band is prominent in the young and juveniles. It is only faintly visible in formalin specimens of the adult males. The fins of *micropogon* and *leptocephalus* are usually colored olive-yellowish,

whereas in *biguttatus* the dorsal and caudal fins are orange-red and the lower fins are almost transparent with some pale olive and orange. Hubbs (1926: 28) notes that the fins of *micropogon* from Kentucky show considerable red. The red caudal fin in the young of *biguttatus* is a striking difference from the amber colored fins of the other two species.

There is great contrast in the coloration of the breeding males not only from their respective females, but among the three species. In breeding males of *biguttatus* a prominent light stripe is developed dorsally, about the width of a scale, extending from the occiput to the origin of the dorsal fin, and posteriorly from the base of the last dorsal fin ray to the area of the procurrent caudal rays. Also, a very promnient black lateral stripe extends from the head to the base of the caudal fin, much more intensely developed than in the juveniles or mature females, and in great contrast to the olive-black coloration of the body dorso-laterally. The light dorsal and black lateral stripes were observed in life at Sandy Creek on April 25, 1946, while several tuberculate males were gathering stones and moving over their nests. Specimens that were in formalin for several hours had the light dorsal stripe replaced by a dark stripe, and the dark lateral one was faded and only faintly visible. This coloration was not observed by previous writers, and may develop only during a certain phase of the breeding activities, as in the common white sucker, *Catostomus c. commersonii* (Lacépède), where a dark and light lateral stripe and light head streaks are formed (Reighard, 1920) coincident with the spawning period. The dorsal and caudal fins of tuberculate male biguttatus in life are orange-red. There is considerable orange in the pectorals, and the anal and pelvics are pale orange. The upper ray of the pectoral fin is bordered with black; the outer rays of the pelvic and anal fins are bordered in white. The rays of all fins, particularly the dorsal and caudal, contain considerable black pigment in preserved specimens. The postocular spot is large and brilliant vermilion in color. The lower lips are red, the upper lips black. The branchiostegal area is colored red, and this reddish color extends to a line just below the eye and on to the preopercular, opercular, and cheek bones. The opercular membrane is colored intense black, as is the area on the body beneath the opercular flap. The area below the lateral line from the pectorals to the anal fin is suffused with reddish; the belly is orange to a gray-white. The body dorsally is blackish, and the sides above the lateral line are olive-black. The iris is orange-brown. In ripe female *biguttatus* during the breeding season period the median fins are orange, and the paired fins are a light yellow-orange. The first rays of the ventral and anal are edged in white. The lateral dark band is only faintly developed, but the caudal spot is more distinct than in the males. The branchiostegals, cheek, opercle, preopercle and belly are light, lacking the red of the male.

Nuptial male *micropogon* in life do not show a conspicuous dark lateral band, and no light dorsal streak was observed as in *biguttatus*. Specimens preserved in formalin for less than an hour showed the belly, branchiostegal area and lower jaw colored reddish to suffuse with red. The dorsal and caudal fins were yellowish with some red near the tips of the rays and bordered with a tinge of white. The anal, pectoral and pelvic fins were olive-yellow with the

tips of the rays whitish. There was considerable black pigment on the rays of the fins, especially the caudal and dorsal. The lateral band was faint and colored a diffuse black. A black crescent was present behind the opercular flap, extending from the lateral line area to the base of the pectoral fins. The cheek and opercle were suffuse with red. The caudal spot was faint and diffuse. In ripe female *micropogon* the colors of the fins were not so pronounced, the pectoral, pelvic and anal having a pale yellowish color. The belly was whitish, and the red colors of the male were replaced by light gray tones. The sides and back were olive-black, and the lateral band and caudal spot were nearly similar to those of the males.

The colors of breeding male *leptocephalus* are likewise greatly accentuated over those of the females. Of interest is the difference in the coloration of nuptial male *leptocephalus* from the Yadkin River compared to those observed from the Neuse and Roanoke Rivers. Large tuberculate males captured over their nests on June 8, 1947, from the Dan River, Roanoke River drainage, Virginia, had a deep orange lateral stripe in life, about 2 to 3 scale-rows wide, located horizontally just above the lateral line. The head, opercle, preopercle, snout, and lower jaw were colored a deep blue. The pectoral, pelvic, and anal fins were almost orange, and the dorsal and caudal were light orange with black colored rays. The body, dorsally, was bluish-black. Tuberculate males taken from a tributary of the Flat River, Neuse drainage, North Carolina, on April 2, 1940, had the lateral stripe and head colors quite like the Roanoke specimens except that the colors were not so intensely developed. However, a large tuberculate male collected near a nest in a tributary of the Ararat River, tributary to the Yadkin River, Pedee drainage, North Carolina, on June 23, 1946, did not have the prominent orange lateral stripe. The body, laterally, was colored bluish, with dull brown to darker colors dorsally while the belly was of a light blue. Other color differences were noted. These differences in colors of nuptial *leptocephalus* may be related to some differentiation of this species in the rivers of the Atlantic slope. Adult female *leptocephalus* collected during the spawning season had none of the bright blue and orange colors of the males, and no prominent lateral stripe. The colors were mainly like those presented for the non-breeding adults above. Specimens observed from the Yadkin River had considerable blue on the body, laterally and dorsally, while those from the Roanoke were usually brassy on the sides.

Other sexual dimorphic characters are the greater size attained by the males of the three species, more rapid rates of growth, and slightly larger dorsal, anal and paired fins (Table 1).

Nuptial males.—The number, shape, size, and distribution of the nuptial tubercles is different in the three species and easily separates them. These are usually developed in males three years of age or older. The tubercles are usually developed in the early spring months and are torn away during the spawning period or drop off during the post-spawning period. The cavities thus formed sometimes become infested with water fungus (*Saprolegnia*). Old males usually have a good growth of this mold on their heads after spawning. Some tubercles are, undoubtedly, broken off during the nest

guarding activities when intruders and egg predators are driven away. Tubercles were well formed in some specimens of *micropogon* collected in September, 1941, from the Susquehanna drainage of New York, whereas ripe males collected April 25, 1946, from Sandy Creek, Monroe County, New York, had undeveloped tubercles. None of these specimens had nuptial crests.

Some of the more pronounced characters differentiating the nuptial males are given below:

bigutatus	*micropogon*	*leptocephalus*
1. Occipital and interorbital swelling not developed.	1. Occipital and interorbital swelling developed.	1. Occipital and interorbital swelling developed.
2. Prominent vermilion spot present behind eye.	2. Spot absent.	2. Spot absent.
3. Head tubercles numerous, usually more than 45, ranging from 40 to 60.	3. Head tubercles fewer, usually under 40, ranging from about 25 to 45.	3. Head tubercles fewer, usually under 30.
4. Head tubercles small and antrorse.	4. Head tubercles large and erect.	4. Head tubercles large and erect.
5. Head tubercles located from internasal area to occiput, sometimes on nape. Rarely below orbital-nasal line.	5. Head tubercles located primarily on internasal area and on sides and front of snout.	5. Head tubercles located primarily between internasal and interorbital area, approaching occipital area; a few tubercles sometimes developed on sides and front of snout.
6. Intense black horizontal stripe on mid-side of body prominent during breeding period; not present in specimens preserved for several hours.	6. Stripe faint and diffuse.	6. Stripe of light tan to orange observed in specimens from the Roanoke and Neuse Rivers.
7. A mid-dorsal light stripe about as wide as a scale, developed from the occiput to the procurrent rays of caudal fin. Absent in specimens preserved for several hours.	7. No dorsal white stripe observed.	7. No dorsal white stripe observed.
8. Dorsal and caudal fins colored orange-red.	8. Dorsal and caudal fins generally colored olive-yellow, with diffuse orange.	8. Dorsal fin colored light orange to light orange-yellow. Caudal fin light olive to light blue.

AGE AND GROUP

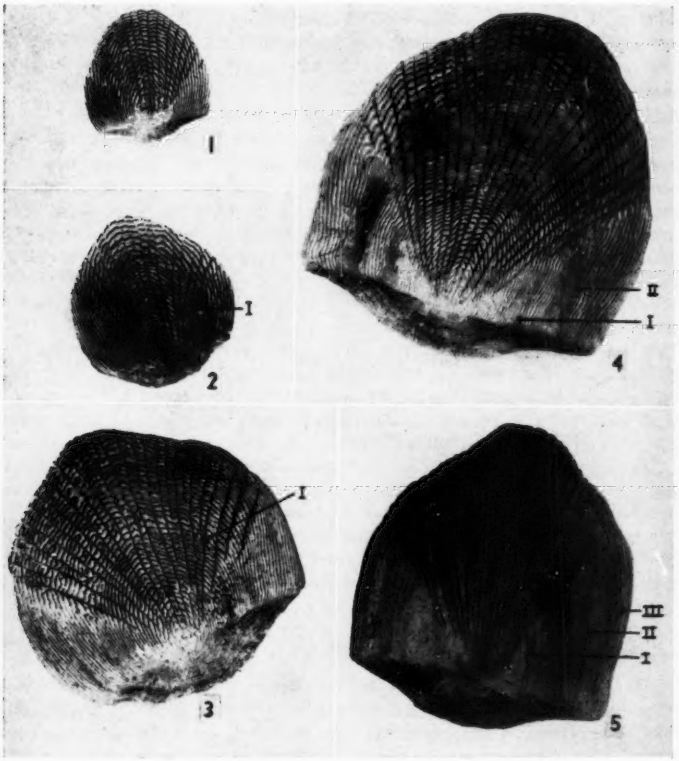
Material studied.—Little information is available concerning the age and rate of growth of the chubs other than a few generalizations (Hubbs and Cooper, 1936: 18, 49). The present study was made by scale analysis of 1709 specimens collected from localities in New York, Pennsylvania, Virginia, and North Carolina. These specimens were caught mainly with a fine mesh

seine. A total of 762 specimens of *biguttatus* and *micropogon* were taken together in Sandy Creek, Lake Ontario drainage, Monroe County, New York, on July 19, August 5, and September 25, 1939; June 10, 1940; and from Johnson's Creek, Lake Ontario drainage, Orleans County, New York, on July 21, 1939. Small collections of *micropogon* were taken from 1938 to 1942 in Catatonk Creek, Susquehanna River system, New York, and the Shenango and Allegheny Rivers, Ohio River system, western Pennsylvania. Additional specimens of *biguttatus* were collected through the same years in Otter Creek, Mercer County, Pennsylvania. These collections with additional material in the Cornell University Museum provided the necessary sequential size groups for age determination. A sample of 77 speciemns of *micropogon*, collected June 14, 1937, from Fifteen Mile Creek, Holston River system, Virginia, by Leonard P. Schultz and E. D. Reid, was examined. The growth data concerning *leptocephalus* was based mainly on two collections, one sample of 612 juveniles and adults and 2 vials of young taken June 18, 1937, from a tributary of the Catawba River, James River system, North of Fincastle, Virginia, collected also by Schultz and Reid. Another collection of 179 specimens was taken from the Catawba River, James River system, one mile south of Old Fort, McDowell County, North Carolina, by Edward C. Raney and the writer. Other collections of *leptocephalus* in the Cornell University Museum were available for study, collected in Virginia and North Carolina during latter March and April, 1940 and 1941.

Sex ratio.—The sex ratio for each group among the three species is variable. In the lower age groups, 0 and 1, of *micropogon* (Table 2), the males outnumbered the females, whereas in *leptocephalus* there were about 2½ females for each male in the one-year age group. There were more females than males in the age groups of two years or older in the three spcies, but the data are too variable to form even tentative conclusions. In one group of 464 *leptocephalus*, all in their second summer's growth (Table 5), the ratio was 1 male to 4.7 females. The ratio for all age groups in *biguttatus* was 1:1.3 (males; females); in *micropogon*, 1:0.9; and in *leptocephalus* 1:2.3.

Description of the scales.—Scales were taken from specimens of different sizes and sexes, were cleaned and mounted in glycerine jelly. When a familiarity of the annulus formation had been acquired, the scales were no longer mounted for microscope examination but were read while in the water of a watch glass. Descriptions of the scales of *biguttatus* and *micropogon* have been presented by Lagler (1936: 19-20, pl. 1, fig. 2; 1947: fig. 21). Cockerell and Allison (1909: 161-162) recognized *Nocomis* Girard as a distinct genus from *Hybopsis* Agassiz on the basis of structural differences in the scales. There is a great similarity among the scales of the three species studied. The features that best characterize these cycloid scales (Figs. 1 to 5) are a subbasal focus; eccentric circuli, becoming very irregular in the posterior field and forming a sharp angle, about 80°, on the lateral-anterior area. The radii are limited to the posterior field and are not greatly convergent. *N. biguttatus* has a broader scale than *micropogon* or *leptocephalus*, usually a little broader than long. The primary radii are more numerous in *micropogon* and *leptocephalus* than in *biguttatus*, ranging from 6 to 12 in *biguttatus*. The shape of

the scale varies considerably with size of scale, age of specimen and the area of the body from which the scale was taken. In the older specimens it was



Figs. 1-5.—1. Scale from a male *Nocomis leptocephalus* 40 mm. in standard length, collected April 3, 1940 from the Catawba River, McDowell Co., James River system, North Carolina, with no annulus formed; 2. Scale from a male *Nocomis micropogon*, 65 mm. in standard length, collected June 14, 1937 from Fifteen Mile Creek, tributary to South Ford, Holston River, Virginia. The widely spaced circuli following the annulus mark the period of most rapid growth; 3. Scale from a male *Nocomis biguttatus*, 93 mm. in standard length, collected September 25, 1939 from Sandy Creek, Monroe Co., New York. The second summer's growth is nearly completed; 4. Scale from a male *Nocomis micropogon*, 121 mm. in standard length, collected June 14, 1937 from Fifteen Mile Creek, tributary to South Fork, Holston River, Virginia. Two annuli are present and the characteristic "banding" of the circuli is especially noticeable on the lateral fields of the scale; 5. Scale from a male *Nocomis leptocephalus*, 145 mm. in standard length, collected March 31, 1940 from Catawba Creek, tributary to the James River system, Botetourt Co., Virginia. This specimen lived through four winters.

sometimes necessary to examine more than ten scales from a single specimen from various parts of the body before the age could be determined.

Determination of age.—Using the scale method for age determination, the rate of growth of a number of cyprinids was studied. Some of these species are: the northern creek chub, *Semotilus a. atromaculatus* (Greeley, 1930), the western golden shiner, *Notemigonous crysoleucas auratus* (Cooper, 1936), the common shiner, *Notropis c. cornutus* (Ryer, 1938), the central common shiner, *Notropis cornutus chrysocephalus* (Marshall, 1939), the satinfin shiner, *Notropis analostanus* and the spotfin shiner, *Notropis spilopterus* (Stone, 1940).

The annulus is formed with the resumption of growth generally in latter April or May. It is interpreted as the point where growth ceases during the winter period and is resumed in the spring. It is designated by Roman numerals in Figs. 1 to 5. The time of formation of the annulus is variable with age, locality, climate, and probably other factors. A large male *micropogon*, 170 mm. in length, collected May 27, 1935, from Wolf Creek, Butler County, Pennsylvania, had the fourth annulus formed at the lateral margin of the scale. Another male *micropogon*, 188 mm. in length, collected on May 5, 1940, from the Shenango River, Mercer County, Pennsylvania, had 3 annuli with the fourth not yet formed. A mature, unspent female *micropogon*, 105 mm. in length, collected April 25, 1946, from Sandy Creek, Monroe County, New York, had the second annulus just visible on the lateral margins of the scale, while several mature, unspent males, between 110-125 mm. had the second annulus visible on the lateral and posterior fields with 1 or 2 circuli formed beyond it. Scales from immature *micropogon* from the same collection showed the first annulus well formed with about 2 circuli developed on the margin. Scales from adults that were two or three years old, collected from this same locality on June 10, 1940, displayed the annulus with 2 to 3 circuli developed beyond it, whereas the juveniles with a single annulus formed usually had 4 to 5 marginal circuli. These data would indicate that a little growth may take place prior to the spawning period in the adults, and more growth in immature specimens. Similar conditions were observed on the scales of *biguttatus*. Several ripe male and female specimens from Sandy Creek, Monroe County, New York, collected on April 25, 1946, showed the second annulus formed just at the lateral edge of the scale, and several older males had the third annulus at the lateral margin, while in other adults the annulus was not yet formed. All of the juvenile *biguttatus* at this time showed one well developed annulus, with about 2 circuli developed after it. The formation of the circuli on the scales of *biguttatus* during early June was similar to that described above for *micropogon*. Not as many sequential collections for early spring were available for *leptocephalus*. No specimens collected on April 3, 1940, from the Catawba River, James River drainage, North Carolina, revealed the formation of an annulus (Table 5, Fig. 1) but several specimens from other localities of the James River taken during the first week of April 1940 had a marginal annulus. Specimens collected during mid-June 1937 from the James River, Virginia, showed considerable growth following the formation of the annulus, particularly in the juveniles, with

usually 4 to 6 widely spaced circuli beyond the annulus, compared with only 2 circuli in the two and three year old adults.

These data of annulus formation in *leptocephalus* relate closely to its formation in *biguttatus* and *micropogon*. In the three species the annulus was formed during latter April or May. It was formed earlier in the juveniles than in the adults. The energies of the adults were probably expended in completion of the breeding activities, and annulus formation was coincidental with the end of this period, after which rapid growth resumes.

The circuli are widely spaced when growth is more rapid, especially during June and July and closer together when less growth takes place in latter August and September. This growth condition has also been observed on the scales of a centrarchid fish (Creaser, 1926), a percid (Raney and Lachner, 1943; Lachner, Westlake and Handwerk, 1950) and a cyprinid (Greeley, 1930). The spacing is not so pronounced from scales of the young (Fig. 1) as it is in the juveniles and adults (Figs. 2 to 5). Thus a "banding" of widely and closely spaced circuli, noticeably particularly in the lateral field, also mark a year's growth. This is more characteristic during the second and third years of life and is illustrated on the scale of a male *micropogon* in its third summer's growth (Fig. 4). In adults over three years of age the rate of growth is greatly reduced; fewer circuli are formed, and the annuli are narrowly spaced. Sometimes a "marginal erosion" of the circuli appears in the spring in specimens of old males which leaves a clear band coinciding with the annulus. The annulus is distinct and well formed at the beginning of the second summer's growth (Fig. 2) and is easily seen in the posterior and lateral fields.

Longevity.—From the results of age determination of 1709 specimens of *Nocomis* it was found that all are relatively short-lived species. The age of 401 specimens of *biguttatus* was determined, and the data are summarized in Tables 3a, 3b, and 6. Of this group, no males and only one female had survived the fourth summer. Only 6 males (1.5 per cent) and 34 females (8.5 per cent) of the sampled population were in their third summer. The largest male was taken in Sandy Creek, Monroe County, New York, on September 25, 1939, in its third summer and measured 124 mm. in length. The largest female taken at the same time was in its fourth summer's growth and measured 118 mm. These data are somewhat contrary to reports from other localities. Hubbs and Cooper (1936: 49) list the maximum length for the males at about 8 inches and state that probably three to four years are required for this species to reach maturity. Hubbs and Ortenburger (1929: 65) record a breeding male from Oklahoma 170 mm. in length and remark that its size was larger than those occurring in the Great Lakes region. These differences may be related to environmental variations or perhaps racial differentiation. Lengths of 250 mm., about 10 inches, are regarded as extremely large but have been recorded (Pratt, 1935: 84; Eddy and Surber, 1943: 131). Efforts were made by the writer to capture the large specimens. In Sandy Creek the clear shallow water up to 3 feet in depth enabled two men to seine effectively with a 4 x 10 ft. net. Large slab rocks, beneath which the larger

chubs often find a place of retreat, were frequently moved. Wire traps were also constructed and set in deeper pools.

The results of the age determination of 454 specimens of *micropogon* are summarized in Tables 4a to 4d and 6. Of these specimens, but one male, 155 mm. in length, was in its fifth summer's growth. Five males, 1.1 per cent of the sampled population, and 7 females, 1.5 per cent, were in their fourth summer, while 30 males, 6.6 per cent, and 51 females, 10.1 per cent were in their third summer. Hubbs and Cooper (1936: 18) state that the river chub, golden shiner, common shiner, and creek chub often live to be five to seven years old. The above data would indicate *micropogon* to survive to a greater age than *biguttatus*. The largest *micropogon* seen was a male, 188 mm. in standard length, 224 mm. in total length, that had lived through four winters, and was taken from a deep pool with a plug by George Hollibaugh on May 5, 1940, from the Shenango River, Mercer County, Pennsylvania. This was also the largest specimen examined in over 2,000 of the three species. The largest female *micropogon* was 127 mm. in length and had completed its fourth summer.

A summary of the results of the age determination of 819 specimens of *leptocephalus* is presented in Tables 5 and 6. Only 1 male and 12 females, 1.4 per cent, were taken in their fourth summer's growth, while 49 males, 5.8 per cent, and 89 females, 10.4 per cent, were in their third summer. The age attained by *leptocephalus* appears to be intermediate between *micropogon* and *biguttatus*, based upon the data in the aforementioned tables. Apparently more females than males of the three species survive the fourth summer of life (Table 2). The largest male *leptocephalus* was 145 mm. in length, taken March 31, 1940, from the James River, Virginia, and the largest female was but 102 mm. from the same locality, in its fourth summer.

Rate of growth.—The growth data of 401 specimens of *biguttatus* taken from Sandy Creek and Johnson's Creek, Lake Ontario drainage during July, August, and September of 1939 and June 1940 are presented in Tables 3a, 3b, and Fig. 6. A great range in length occurred in each of the age groups. The males grow more rapidly than the females, and the differences are statistically significant at the end of the first year. (Probability, P, is between .05 and .01 for young of September 25, 1939, and P equals .001 for the 1+ age group of June 10, 1940). Although the data of June 10, 1940, are not truly comparable with the data of July 19, August 5, and September 25, 1939, concerning summer growth, a greater increment is noted during June and July than August and September (Fig. 6). This growth difference was also observed in the structure of the scale; during June the circuli are more widely separated (Fig. 2) than during September (Fig. 3).

When comparing the length frequency distributions of the various age groups, no overlap occurred between the young of the year and those specimens in their second summer for the month of July. However, by September a few of the faster growing young equaled or exceeded in size some of those two summers in age. In the same age groups, considering the sexes separately, no overlap occurred among the males, and only a 2 mm. overlap occurred among the females during September. The differences of the average length

of specimens in their second and third summers, sexes separate, were less than those in their first and second summers. The range of lengths did not overlap greatly. Should a length-frequency curve be constructed of the data presented in Tables 3a and 3b, only 1.0 per cent of all specimens would overlap. The males of *biguttatus* attain a mean length of 56 mm. (range 37 to 67 mm.), 90 mm. (73 to 109 mm.) and 123 mm. (121 to 124 mm.) at the end of their first, second, and third summer's growth, (September 25), respectively. Females reach a mean length of 49 mm. (36 to 59 mm.), 86 mm. (57 to 95 mm.), and 106 mm. (98 to 112 mm.) at the end of the same growth periods. There is a striking similarity between the means and ranges of the lengths for

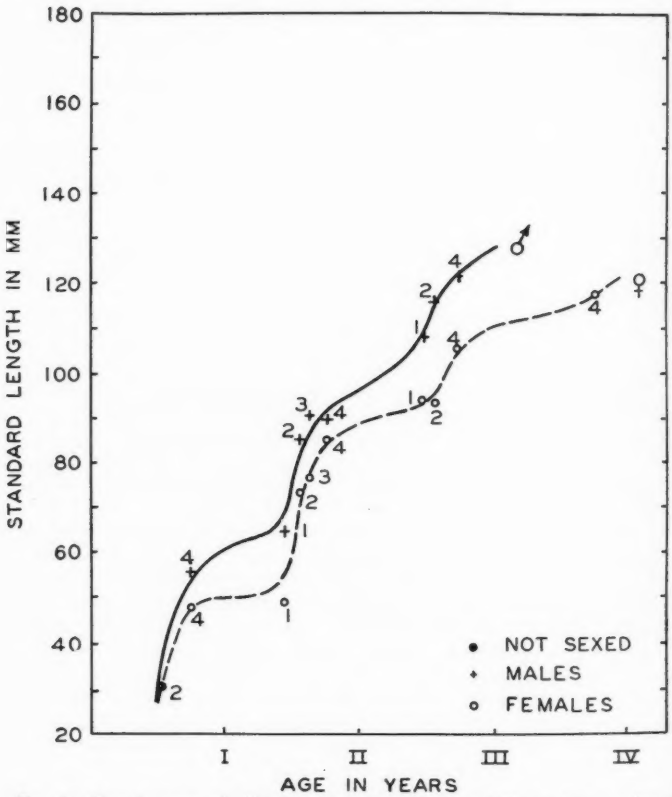


Fig. 6.—Growth curve of *Nocomis biguttatus* based on 302 specimens collected during July (marked 2 on curve), August (3), and September (4), 1939 and June (1), 1940 from Sandy Creek, Lake Ontario drainage, New York.

all age groups of *biguttatus* in Table 3a for specimens collected July 19, 1939, from Sandy Creek, and the means and ranges of specimens taken two days later in Johnson's Creek, both Lake Ontario drainage, New York. Sufficient comparative material was not available from other drainages.

The growth data of 454 specimens of *micropogon* taken from several localities in New York and Virginia are given in Tables 4a to 4d and Fig. 7. As in *biguttatus* great ranges occurred in the lengths of the various age groups, the greatest range extending from 55 to 192 mm. in male *micropogon* in their second summer, taken June 14, 1937, from the Holston River, Virginia. The males also attain a greater length than the females, statistically different at the

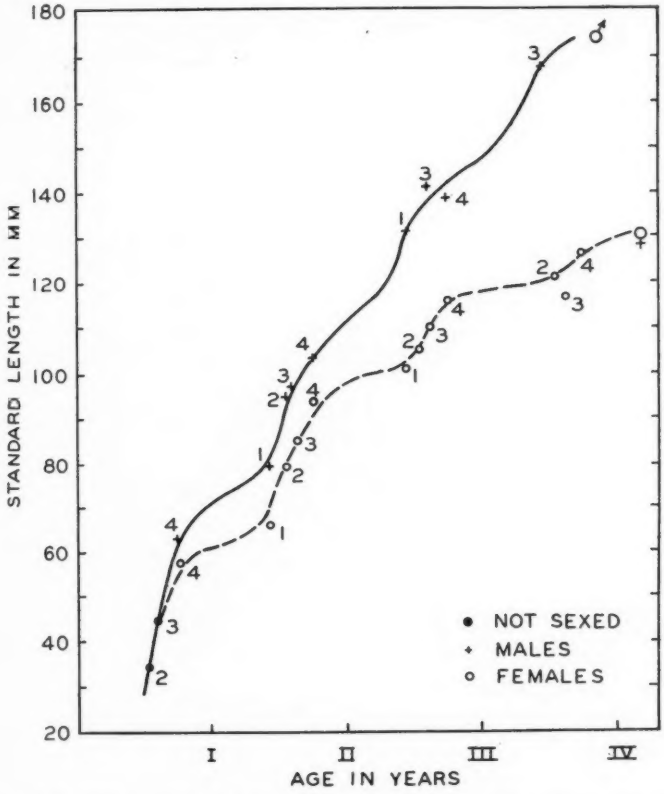


Fig. 7.—Growth curve of *Nocomis micropogon* based on 361 specimens collected during July (2), August (3), and September (4), 1939 and June (1), 1940 from Sandy Creek, Lake Ontario drainage, New York.

end of the first summer's growth. ($P = .001$ for young of September 25, 1939, Fig. 7). The growth increment was somewhat greater during early summer. The length-frequency distribution of the young of both sexes did not overlap with their respective sexes in the second summer, and the means were noticeably different (See September 25, 1939, Sandy Creek, Table 4d). However, great errors would occur in computing age from length-frequency distributions, for the lengths of specimens in their second summer and older greatly overlap (See June 14, 1937, Holston River, Virginia, Table 4b). The

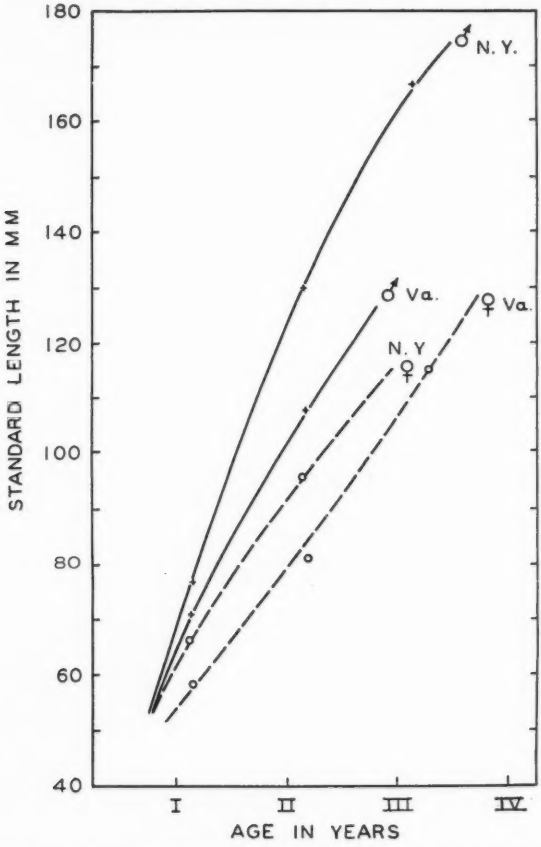


Fig. 8.—Curves showing variable growth rate of *Nocomis micropogon* based on 77 specimens collected June 14, 1937 from Fifteen Mile Creek, Holston River, Virginia and 86 specimens collected June 10, 1940 from Sandy Creek, Monroe County, New York.

males of *micropogon* attain a mean length of 63 mm. (46 to 75 mm.), 103 mm. (88 to 133 mm.), and 138 mm. (124 to 150 mm.) at the end of their first, second, and third summer's growth respectively. Females reach a mean length of 57 mm. (43 to 68 mm.), 94 mm. (82 to 107 mm.) and 111 mm. (99 to 125 mm.) at the end of the same growth periods. The rate of growth varied in specimens taken from different localities in different years. Two-year-old male *micropogon* from Sandy Creek, New York, collected June 10, 1940, averaged 131 mm. in length compared with 107 mm. for specimens from the Holston River, Virginia, taken on June 14, 1937, and 86 mm. for specimens taken on June 11, 1939, from Catatonk Creek, Susquehanna River, New York. The females showed a corresponding difference in growth. Comparative data for these three localities are given in Tables 4a to 4d, and the Sandy Creek and Holston River data are graphically compared in Fig. 8.

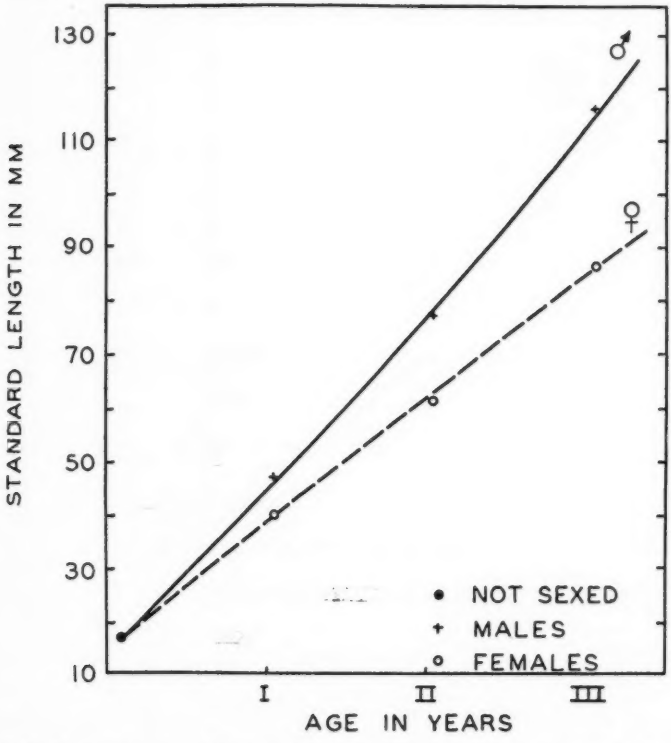


Fig. 9.—Growth curve of *Nocomis leptocephalus* based on 679 specimens collected June 18, 1937 from the James River system, Virginia

The growth data for *leptocephalus*, based on two collections from the James River, totaling 849 specimens, are given in Table 5 and Figs. 9 and 10. The young of 679 specimens taken June 18, 1937, were 16 mm. in length, (range 10 to 20 mm.); one-year-old males, 47 mm. (32 to 68 mm.); one-year-old females, 40 mm. (28 to 61 mm.); two-year-old males, 77 mm. (59 to 104

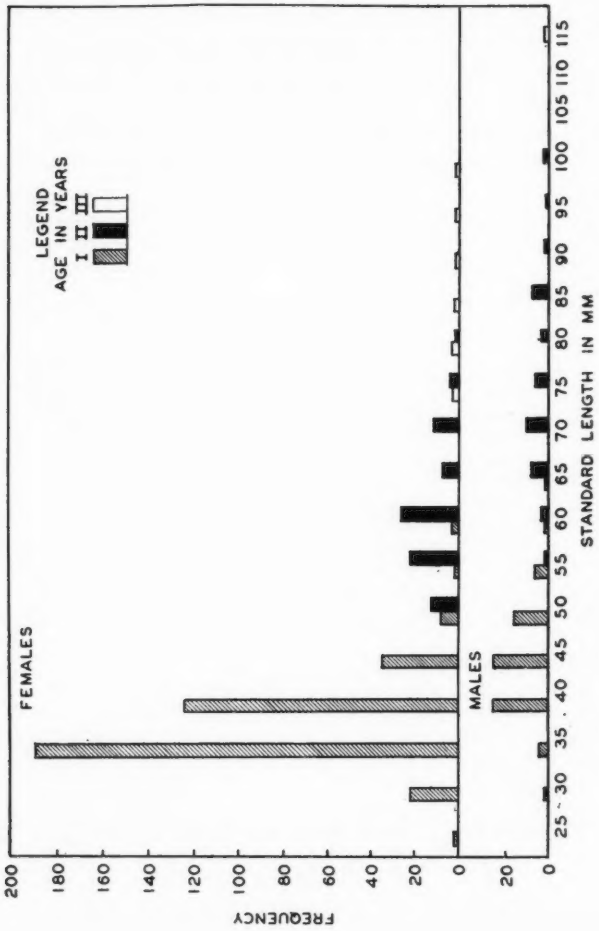


Fig. 10.—Age-frequency distribution of 621 *Nocomis leptocephalus* collected June 18, 1937 from a tributary of the Catawba River, James River system, Virginia

mm.); two-year-old females, 62 mm. (50 to 80 mm.); three-year-old males, 116 mm.; females, 86 mm. (Fig. 9). The age-frequency distributions of the same data, excluding the young of the year, are presented graphically in Fig. 10. The length-freqeuncy distribution showed considerable overlap, particularly between one and two-year-old females, amounting to 16 per cent. The differential rate of growth was again greater in the males and significantly different at the end of the first year. ($P = .001$ for the one-year age groups for both April 3, 1940 and June 18, 1937 collections). When comparing

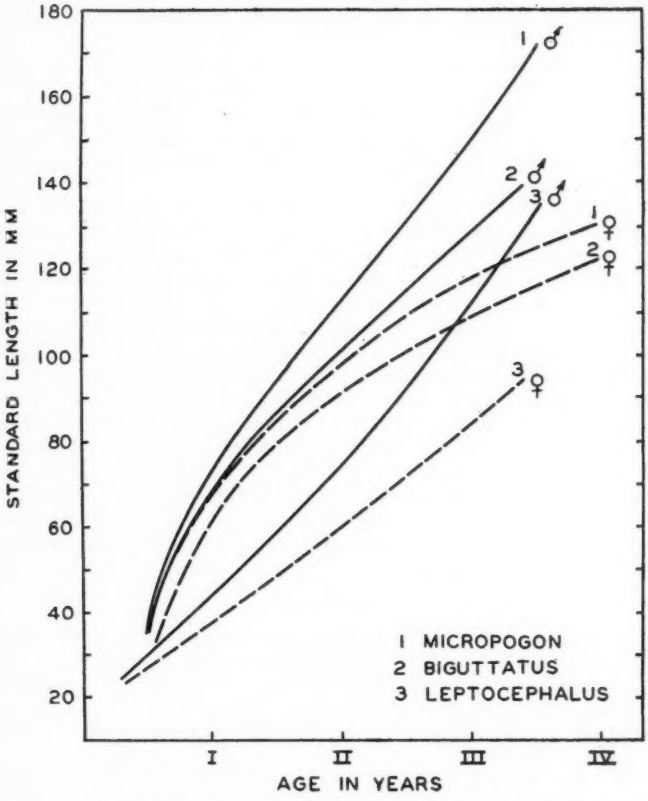


Fig. 11.—Curves showing the comparative growth rate of the three species of *Nocomis* inhabiting Northeastern United States, based on 679 specimens of *leptocephalus* collected June 18, 1937 from the James River system, Virginia, 302 specimens of *biguttatus* and 361 specimens of *micropogon* collected July 19, August 5, and September 25, 1939 and June 10, 1940 from Sandy Creek, Lake Ontario drainage, New York.

the means of the sexes among the various age groups in these two collections (Table 5), only small growth differences could be detected. Assuming that habitat and climatic factors affecting growth of these samples were identical, the difference in growth of the one-year-old group from early April to mid-June would be about 5 to 10 mm. in length. Since the annulus was not yet formed in the April 3 collection, and about 4 circuli developed beyond the annulus in the one-year-old specimens for the June sample, this scale growth may represent an increase of about 5-10 mm. in length. The *leptocephalus* from the James River grew more slowly and attained a smaller mean length than did either *biguttatus* or *micropogon*. The comparative growth rates of both sexes of the three species are illustrated in Fig. 11. *N. micropogon* had the most rapid rate of growth and attained the greatest size. A comparison of the annual increment in length of the three species is given in Fig. 12. In *micropogon* and *biguttatus* the most rapid increment occurred the first year of life with greatly reduced increments the second and third years particularly among the females. In *leptocephalus* the length increments were about equal through the three years of life.

It has been shown that sexual dimorphism in rate of growth is characteristic. It is probably not related to sexual maturity in *Nocomis*, as the case may be in *Notemigonus* (Cooper, 1936: 594), for the young of the year of all three species were immature, yet the sexes had attained a significant difference in rate of growth. It has been thought (Raney and Lachner, 1943: 236, 237) that in cyprinids such as *N. biguttatus, N. micropogon, Semotilus corporalis, Semotilus a. atromaculatus,* and other species that bulid a nest, or in *Hybognathus* (Van Cleave and Markus, 1929) that guards the nest, the males exceed the females in size; and on the other hand, among the cyprinids that do not build a nest, like *Hybognathus regius, Notropis rubellus,* and *Notemigonus crysoleucas auratus,* the females are larger than the males. These relations are paralleled in the Percidae. In those percid fishes in which the males guard the nest, such as *Boleosoma, Poecilichthys flabellaris,* and *P. maculatus,* the males are larger than the females, whereas in those not guarding the nests the sexes are of about the same size (*Hadropterus maculatus*), or the females are larger (*Perca flavescens*).

SUMMARY

Three species of Cyprinidae found in eastern United States were studied, the hornyhead chub, *Nocomis biguttatus* (Kirtland), the river chub, *N. micropogon* (Cope) and the eastern Piedmont chub, *N. leptocephalus* (Girard). Their distribution and habitat are discussed.

The three species are generally common throughout their range, frequently becoming locally abundant.

Their nest building habits, nest associates and interrelationships with other cyprinids during breeding activities are reviewed.

They usually become mature at three years of age, when they spawn probably for the first time. Faster growing individuals of *biguttatus* are mature and perform breeding activities at two years of age.

Characteristics of the nuptial males of the three species are described.

Fig. 12.—Annual increment in length of the three species of *Nocomis* inhabiting Northeastern United States. The curves are based on 106 specimens of *biguttatus* and 175 specimens of *micropogon*, taken September 25, 1939 from Sandy Creek, Monroe Co., New York and 679 specimens of *leptocephalus*, taken June 18, 1937 from the James River system, Virginia.

Pronounced sexual dimorphism exists. The males develop prominent breeding tubercles over their heads. Large crests are formed on the heads of *micropogon* and *leptocephalus* during the breeding period. Brilliant colors are also developed by the males at this time. They attain a larger size, grow more rapidly and have somewhat larger dorsal, anal, and paired fins, than the females.

The sex ratio found for all age groups in *biguttatus* was 1:1.3 (males:females) in 401 specimens examined; in *micropogon* 1:0.9 in 454 specimens; and in *leptocephalus* 1:2.3 in 849 specimens.

The characteristics of the scale of *Nocomis* and the formation of the annulus is discussed. The annulus is formed with the resumption of growth, usually in latter April or May in all three species. The time of the formation of the annulus is influenced by maturity, forming somewhat earlier in the young and juveniles than in mature adults. The annulus is formed in ripe specimens of *biguttatus* and *micropogon* in April, and may indicate that some mature specimens also grow a little, prior to the spawning period.

During periods of more rapid growth, June and July, the circuli are more widely spaced than during periods of slower growth, August and September.

All three species are relatively short-lived. *N. micropogon* lived longest; one male was found in its fifth summer, representing a fraction of one per cent of the sampled population studied. *N. biguttatus* is the shortest lived, and *leptocephalus* is intermediate in this respect.

More females than males of the three species survive to the age of four summers, and no single sex formed more than 1.5 per cent of the populations sampled.

The largest specimens recorded were: *micropogon*, male, 188 mm. in standard length, female, 127 mm.; *biguttatus*, male, 124 mm., female, 118 mm.; *leptocephalus*, male, 145 mm. and female, 102 mm.

N. leptocephalus grows more slowly and does not attain as great a length as either *micropogon* or *biguttatus*. In *micropogon* from Sandy Creek, New York, the males attain a mean standard length of 63 mm. (46-75 mm.); 103 mm. (88-133 mm.); and 138 mm. (124-150 mm.) at the end of the first, second, and third summers of life. Females reach 57 mm. (43-68 mm.); 94 mm. (82-107 mm.); and 111 mm. (99-125 mm.) for the same growth periods. Similar data for *biguttatus* are: males, 56 mm. (37-67 mm.); 90 mm. (73-109 mm.); and 123 mm. (121-124 mm.); females, 49 mm. (36-59 mm.); 86 mm. (57-95 mm.); and 106 mm. (98-112 mm.). In *leptocephalus* from the James River, Virginia, the males attain a size of 47 mm. (32-68 mm.); 77 mm. (59-104 mm.); and 116 mm. at the end of the first, second, and third years. Females reach 40 mm. (28-61 mm.); 62 mm. (50-80 mm.); and 86 mm.

The males of the three speices grow more rapidly than the females, and this difference in the rate of growth is observable at the end of the first year.

The growth increment is somewhat greater during early summer, June and July, than late summer, August and September.

The annual increment in length is greatest during the first year in *micro-*

pogon and *biguttatus*, for both sexes, with greatly reduced increments the second and third years. In *leptocephalus* the annual increments are about equal through the three years of life.

ACKNOWLEDGMENTS

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TABLE 1.—Measurements of the fins of three species of *Nocomis*

Species	*biguttatus*		*micropogon*		*leptocephalus*	
Locality	Sandy Creek, Lake Ontario drainage, N. Y.		Sandy Creek, Lake Ontario drainage, N. Y.		James and Roanoke River systems Va. and N. C. Atlantic drainage	
Sex	♂	♀	♂	♀	♂	♀
Number measured	16	9	13	12	15	10
Standard length in mm.						
Mean	106.5	87.8	120.5	95.7	106.1	86.7
Range	(93-125)	(80-100)	(97-148)	(88-112)	(80-145)	(75-97)
In standard length						
Dorsal fin, depressed	4.24 (4.0-4.6)	4.50 (4.3-4.6)	4.30 (4.0-4.7)	4.71 (4.5-5.0)	4.34 (3.9-4.9)	4.79 (4.4-5.3)
Pectoral fin, longest ray	5.49 (5.1-6.0)	6.04 (5.7-6.5)	5.41 (5.1-5.9)	5.80 (5.2-7.1)	5.21 (5.0-5.6)	5.56 (5.1-6.0)
Pelvic fin, longest ray	5.79 (5.3-7.0)	6.84 (6.5-7.0)	6.67 (6.2-7.1)	6.65 (6.1-7.1)	6.35 (5.9-6.9)	6.79 (6.3-7.2)
Anal fin, longest ray	5.24 (4.8-5.9)	5.74 (5.3-6.0)	5.27 (5.0-5.6)	5.70 (5.4-6.0)	5.17 (4.9-5.6)	5.68 (5.0-6.0)

TABLE 2.—Sex ratio of three species of *Nocomis* from localities in New York, Virginia and North Carolina

Species	*biguttatus*		*micropogon*		*leptocephalus*	
Age in Years	♂	♀	♂	♀	♂	♀
0	29	10	67	51	—	—
1	121	157	133	99	183	450
2	6	34	30	51	49	93
3	—	1	5	7	2	4
4	—	—	1	—	—	—
Ratio of all ages, M.-F.	1.0 : 1.3		1.0 : 0.9		1.0 : 2.3	

TABLE 3a.—Length frequencies for each age group (summers of life) of 401 specimens of *Nocomis biguttaus* from New York

S.L.[1] in mm.	Sandy Creek, Monroe Co., N. Y. June 10, 1940				Sandy Creek, Monroe Co., N. Y. July 19, 1939					Johnson's Creek, Orleans Co., N. Y. July 21, 1939				
	I+		II+		O+[2]	I+		II+		O+[2]	I+		II+	
	♂	♀	♂	♀		♂	♀	♂	♀		♂	♀	♂	♀
25					6					2				
30		1			20					1				
35		1			14									
40	1	9												
45	2	6												
50	–	7												
55	2	4												
60	4	5					1					3		
65	2	–					4				1	17		
70	7	1				3	10				1	10		
75	2			1		4	14				10	7		
80	1			–		–	3				16	1		
85				1		10	1				8			3
90				2		6			3		4			7
95				2		1			1		1			4
100				2										2
105			1	1										
110													1	
115								1						
120														
No. of spec.	21	34	1	9	40	24	33	1	4	3	41	38	1	16
Mean	65.4	49.9	108	94.2	33	85.6	74.8	116	93.5	28.6	82.6	70.5	113	94.2
Range	40-82	30-72	—	76-105	27-37	71-95	64-86	—	92-97	27-31	67-96	62-80	—	89-104
S.D.[3]	10.4	10.9	—	—	3.4	7.2	5.1	—	—	—	5.9	4.7	—	4.6

[1] S.L. = Standard length.
[2] Not sexed; these specimens represent young of the year.
[3] S.D. = Standard deviation.

TABLE 3b.—Length frequencies for each age group (summers of life) of 401 specimens of *Nocomis biguttatus* from New York

Sandy Creek, Monroe Co., N. Y. August 5, 1939			Sandy Creek, Monroe Co., N. Y. September 25, 1939							
S.L. in nm.	I+ ♂	I+ ♀	O+ ♂	O+ ♀	I+ ♂	I+ ♀	II+ ♂	II+ ♀	III+ ♀
25									
30									
35			1	1					
40			2	2					
45			2	2					
50			4	3					
55			9	2		1			
60			8			–			
65	1	1	3			1			
70	2	6			1	3			
75	1	3			4	2			
80	–	3			2	6			
85	1	1			4	9			
90	–	–			2	11			
95	4	1			4	4		2	
100	3				1			–	
105	1				3			1	
110	1							2	
115									1
120							3		
No. of spec.	14	15	29	10	21	37	3	5	1
Mean	92	76.9	56.3	48.6	90.3	86.2	122.7	105.6	118
Range	65-110	69-95	37-67	36-59	73-109	57-95	121-124	98-112	—
S.D.	13.9	7.5	7.5	6.5	10.7	8.9	—	—	—

TABLE 4a.—Length frequencies for each age group (summers of life) of 454 specimens of *Nocomis micropogon* from several localities in New York and Virginia

	Sandy Creek, Monroe Co., N. Y. June 10, 1940					Catatonk Creek, Susquehanna River system, N. Y., June 11, 1939						
S.L. in mm.	I+ ♂	I+ ♀	II+ ♂	II+ ♀	III+ ♂	I+ ♂	I+ ♀	II+ ♂	II+ ♀	III+ ♂	III+ ♀	IV+ ♂
30												
35												
40												
45												
50		1										
55	2	7					1					
60	2	5										
65	4	10				1			1			
70	6	7				–			1			
75	3	5				1						
80	8	2						1				
85	8							2				
90	3			2				1				
95				1								
100				–								
105				1							2	
110												
115			2									
120			--									
125			1									
130			1							1		
135			3							–		
140			1							1		
145										–		
150										2		
155												1
160												
165					1							
170												
No. of spec.	36	37	8	4	1	2	1	4	2	4	2	1
Mean	77.1	66.5	130.7	96.0	167	71.0	56.0	86.3	70.0	144	106.5	155
Range	57-91	54-80	117-140	90-105	.....	.....	.....	.....	.....	.....	.....	.....
S.D.	9.8	7.8	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

TABLE 4b.—Length frequencies for each age group (summers of life) of 454 specimens of *Nocomis micropogon* from several localities in New York and Virginia

	Fifteen Mile Creek, Holston R. system, Va. June 14, 1937					Sandy Creek, Monroe Co., N. Y. July 19, 1939				
S.L. in mm.	I+ ♂	I+ ♀	II+ ♂	II+ ♀	III+ ♀	0+	I+ ♂	I+ ♀	II+ ♀	III+ ♀
30						4				
35						5				
40										
45		1								
50		2								
55	3	3								
60	3	6								
65	8	1		1				1		
70	3	1		3				2		
75	1			9			2	4		
80	–			8			1	7		
85	1		1	8			2	1		
90	1		2	–			4			
95	1		–	1			4		1	
100	1		–	–			6		–	
105			–	–			1		4	
110			2	1			1			
115			2		2					
120			–							1
125			1							
130										
135										
140										
145										
150										
155										
160										
165										
170										
No. of spec.	22	14	8	31	2	9	21	15	5	1
Mean	71.2	59.5	107.1	81.6	115.5	34.5	95.1	78.9	105.7	121
Range	55-102	49-70	89-125	65-110	115-116	30-38	77-112	67-87	99-109	.....
S.D.	12.6	6.2	.....	8.2	.....	.....	9.0	5.1	.....	.....

TABLE 4c.—Length frequencies for each age group (summers of life) of 454 specimens of *Nocomis micropogon* from several localities in New York and Virginia

Sandy Creek, Monroe Co., N. Y.
August 5, 1939

S.L. in mm.	O+	I+ ♂	I+ ♀	II+ ♂	II+ ♀	III+ ♀
30						
35						
40						
45	1					
50						
55						
60						
65						
70						
75						
80		4	4			
85		10	5			
90		5	1			
95		10				
100		3				
105		–				
110		1			2	
115						1
120						
125						
130				1		
135				–		
140				–		
145				1		
150						
155						
160						
165						
170						
No. of spec.	1	33	10	2	2	1
Mean	45.0	92.0	85.3	140.5	110.0	116.0
Range	....	83-100	80-92	133-148	.....	.....
S.D.	....	7.0	....	.....	.....	.....

TABLE 4d.—Length frequencies for each age group (summers of life) of 454 specimens of *Nocomis micropogon* from several localities in New York and Virginia

Sandy Creek, Monroe Co., N. Y.
September 25, 1939

S. L. in mm.	O+ ♂	O+ ♀	I+ ♂	I+ ♀	II+ ♂	II+ ♀	III+ ♀
30							
35							
40		1					
45	2	3					
50	4	15					
55	9	18					
60	26	8					
65	15	6					
70	9						
75	2						
80				1			
85			1	3			
90			4	9			
95			3	3		1	
100			4	4		2	
105			4	2		–	
110			1			1	
115			–			2	
120			–		1	–	
125			–		–	1	1
130			2		2		
135					1		
140					1		
145					2		
150					1		
155							
160							
165							
170							
No. of spec.	67	51	19	22	8	7	1
Mean	63.1	56.7	103.2	94.1	138.2	110.7	127.0
Range	46-75	43-68	88-133	82-107	124-150	99-125	.....
S.D.	6.5	5.8	11.9	6.6	.....	.....	.....

TABLE 5.—Length frequencies for each age group (summers of life) of 849 specimens

TABLE 5.—Length frequencies for each age group (summers of life) of 849 specimens of *Nocomis leptocephalus* from Virginia and North Carolina

	Catawba R., James R. system, 1 mi. S. of Old Fort, McDowell Co., N. Car. April 3, 1940						Trib. of Catawba R., James R. system, North of Fincastle, Va. June 18, 1937						
S.L. in mm.	I ♂	I ♀	II ♂	II ♀	III ♂	III ♀	0+	I+ ♂	I+ ♀	II+ ♂	II+ ♀	III+ ♂	III+ ♀
10							16						
15							40						
20							2						
25		2							1				
30	13	32						1	22				
35	59	29						5	188				
40	26	4						25	123				
45	2	1						25	35				
50	1			3				16	9		13		
55				3				7	1	2	23		
60			1					1	3	4	26		
65								1		8	8		
70						2				10	12		
75										6	4		3
80										4	1		3
85										8			2
90										2			2
95					1					1			1
100										3			1
105													
110													
115												1	
No. of spec.	101	68	1	6	1	2	58	82	382	48	87	1	12
Mean	37.4	34.6	63.0	54.5	95.0	71.0	16.3	46.7	39.8	77.0	61.5	116	86.0
Range	30-51	29-45	....	51-57	....	....	10-20	32-68	28-61	59-104	50-80	.....	75-102
S.D.	3.6	3.7	....	....	....	....	2.6	6.2	6.0	11.6	7.3	.....	.....

TABLE 6.—Number of *Nocomis*, in per cent of sampled population, attaining an age of 3 summers or more. (figures based on data in Tables 3, 4 and 5)

	Age in summers					
	3		4		5	
	♂	♀	♂	♀	♂	♀
leptocephalus	5.8	10.4	0.1	1.4	.....	.....
micropogon	6.6	10.1	1.1	1.5	0.2	.....
biguttatus	1.5	8.5	.....	0.3	.....	.....

ADDENDUM

During the period that this paper was prepared and submitted for publication the systematic status of various genera of North American freshwater fishes were undergoing study and revision by a number of American ichthyologists, particularly by Dr. Reeve M. Bailey, University of Michigan. A result of these studies has lead to a lumping of certain genera. I made no changes in the proof of this paper in that these revised generic concepts do not effect its subject matter.

Studies on the Lizard Family Xantusiidae I.

The Systematic Status of the Baja California Night Lizards Allied to Xantusia vigilis, with the Description of a New Subspecies

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In recent years several series of night lizards allied to the wide-ranging United States species *Xantusia vigilis* have been collected in Baja California. This material is of especial interest, as but three examples of this species group were previously known from the peninsula. In an attempt to determine the relationships of these newly acquired specimens, all Baja California night lizards of the *X. vigilis* complex presently available, have been examined. As a result, I find that three subspecies of *X. vigilis* are distinguishable on the peninsula.

Historical

The first example of the genus *Xantusia* from Baja California was reported by Van Denburgh (1895, p. 121). In his paper he described a new species, *X. gilberti*, on the basis of a single specimen taken at San Francisquito in the Sierra Laguna of the Cape District. The new form was separated from the northern species *X. vigilis* because of its smaller eye and the presence of two frontal shields (one frontal in *vigilis*).

Schmidt (1922, p. 672) recorded a second night lizard from the Sierra Laguna. This example lacked the divided frontal of Van Denburgh's type, but Schmidt considered it to be *X. gilberti*. Material available to him showed that in *X. vigilis* occasional aberrants with two frontals occur. He therefore rejected the nature of the frontal as diagnostic and regarded the holotype of *X. gilberti* peculiar in this respect. He retained the Cope form, however, as a species distinct from *X. vigilis* because of its smaller eye, the narrow separation of the second pair of postmentals (sublabials), and the uniform color of the back versus the back "maculate or lineolate with dark brown spots" in the northern form.

Only two records of *Xantusia vigilis* from the peninsula have been published. Edmund Heller (in Meek, 1905, p. 13) comments upon the occurrence of this species at San Matias Pass in the Sierra San Pedro Mártir approximately 80 miles south of the international boundary. Mr. Clifford H. Pope, curator of reptiles at the Chicago Natural History Museum, informs me that no *Xantusia* of this species from Baja California is in the museum's

collections. It is probable that no specimens were taken by Heller and that the record is based merely upon his field observations.

Schmidt (1922, p. 671) lists a specimen of this form from San Felipe Bay, a point approximately 600 miles north of the type locality of *X. gilberti*. This latter record has constituted the southern known limit of the range of *X. vigilis*.

Klauber (1931, p. 11) saw no examples of *X. gilberti* but found that the characters utilized by Schmidt to distinguish the species from *X. vigilis* were variable in his sample of the latter form. He was reluctant to synonymize *X. gilberti* because of its smaller eye and the wide geographic gap between the two named populations. He did admit that the division was tenuous and suggested that collecting in the area intervening between San Felipe and the Sierra Laguna might prove the two to be conspecific. Two lizards in Klauber's series of *X. vigilis* had two frontals, and this further supports Schmidt's earlier suggestion that the type of *X. gilberti* was abnormal. All subsequent authors have followed Dr. Klauber's tentative conclusions. No additional material of these species has since been reported from Baja California.

In the fall of 1946, Dr. Ira L. Wiggins of Stanford University and two companions, Dr. H. M. Hill of Redlands and Dr. A. M. Vollmer of San Francisco, fulfilled Klauber's expectations when they obtained a series of *Xantusia* of the *vigilis* group from the central part of the peninsula. These specimens immediately re-opened the question of the validity of *X. gilberti*.

In addition, since the appearance of Klauber's synopsis, specimens substantiating the San Matias Pass record of Heller and two unreported examples from the Sierra Laguna had been taken. Then, just as a study of all known lizards of this group from Baja California was near completion, Mr. Charles H. Lowe, Jr. and Mr. Kenneth S. Norris of the University of California, Los Angeles, returned from a summer's collecting trip on the peninsula with a fine series of 27 *Xantusia* from the Sierra Laguna and central portions of Baja California. These gentlemen most graciously allowed me to examine this important material and to incorporate my findings into this paper.

DESCRIPTION OF SUBSPECIES

Throughout this paper when counts or measurements are presented in the following manner: 30 (31) 32, the first figure refers to the lower limit of the range, the figure in parenthesis is the arithmetic mean, and the third figure represents the upper limit of the range.

In the subsequent discussion the abbreviations represent these institutions or individuals: CAS, California Academy of Sciences; CHL, private collection of Charles H. Lowe, Jr., to be deposited in the collections of the University of California, Los Angeles; KNS, collection of Kenneth S. Norris, also to be deposited at the University of California, Los Angeles; MVZ, Museum of Vertebrate Zoology, University of California, Berkeley; SDSNH, San Diego Society of Natural History; SU, Natural History Museum, Stanford University; USNM, United States National Museum.

XANTUSIA VIGILIS GILBERTI Van Denburgh
San Lucan Night Lizard

Xantusia gilberti Van Denburgh, 1895, p. 121 (original description). *Amoebopsis gilberti* Cope, 1895, p. 758 (type of new genus).

Holotype.—California Academy of Sciences 401, collected at San Francisquito, Sierra Laguna, Distrito del Sur, Baja California, Mexico, on March 28, 1892 by Gustav Eisen. In good condition although the color has faded somewhat with age.

Illustrations.—Van Denburgh (1895, pl. ix).

Diagnosis.—A subspecies of *Xantusia vigilis* characterized by: (1) ventral scales usually in 30 or more transverse rows, 29 (30.2) 32; (2) dorsal pattern of large, dark spots widely separated from each other and tending to be concentrated laterally; (3) tail with dark spots restricted to terminus of caudal scales.

General characteristics.—A lizard of typical xantusiid proportions; head wedge-shaped, tapering abruptly, just anterior to the eyes, toward the snout; nostrils placed below the canthus rostralis, not visible from above, circular; eye small, round, lidless, closer to tip of snout than to ear opening; pupil vertically elliptical; ear opening elliptical, oblique; two pregular folds, anterior originating at base of ear openings, posterior a few scales in advance of gular fold; gular fold well developed, usually originating above forelimbs and a little in advance of them; a feebly marked occipital groove present on top of head posterior to the enlarged head shields.

Body elongate, constricted at axilla and groin, roughly cylindrical in cross-section but flattened ventrally; a mid-dorsal groove extending onto base of tail; sometimes an additional faint groove on each side of mid-dorsal; limbs moderate, overlapping slightly when adpressed; tail round, flattened ventrally and tapering rapidly for the last third of its length to a blunt point; peritoneum black.

Measurements.—The two largest examples of this form are 44.0 mm. in length, measured from tip of snout to vent. The smallest specimen is 28.0 mm. in snout-vent length. The propensity of these lizards for shedding their tails at the slightest provocation makes evaluation of the snout-vent to tail-length relationship most difficult, particularly since the regenerated members are very hard to distinguish from normal tails. The tail is approximately the same length as the distance from snout to anus, tending, if anything, to be a little shorter.

The following proportions and measurements are based on 12 specimens of *X. vigilis gilberti* (including the holotype) from the Sierra Laguna. Snout-vent length 28.0 (36.7) 44.0 mm. Head length, measured from tip of snout to anterior margin of ear opening, into snout-vent length 4.2 (4.7) 5.5; head width into head length 1.1 (1.4) 1.7; head depth into head length 1.6 (1.8) 2.3.

Squamation.—Top of head covered with enlarged shields; two internasals between nostrils, in contact with rostral; internasal followed by a frontonasal, paired prefrontals, a single frontal (divided in holotype), two large parietals separated by an interparietal, and two occipitals; frontonasal in contact with internasals, prefrontals, postnasals, and the first loreal on each side; separated from frontal by prefrontals (except in the holotype); prefrontals usually in

contact medially; separating the frontonasal from the frontal (in the holotype the prefrontals do not meet, and the frontonasals is in contact with the frontal anteriorly) and in contact with the second loreal and a superciliary; frontal separated from eye by two superciliaries, in contact with frontoparietails, which separate it from enlarged interparietal; frontoparietals in contact medially, bordered laterally by two or three superciliaries and the single presupratemporal, meeting the parietals broadly at the level of the anterior third of the interparietal; parietals in contact with interparietal, occipital, presupratemporal, and three or four supratemporals; occipitals meeting behind the interparietal and touching four or five supratemporals; interparietal hexagonal, pineal eye located under posterior third of shield.

Rostral broader than high, in contact with internasals and first supralabial on each side; nostril located at juncture of internasal, rostral, first supralabial, and postnasal; postnasal in contact with first supralabial and frontonasal; two loreals, the anterior one smallest, meeting frontal, frontonasal, postnasal, and first and second or second and third supralabials; posterior loreal in contact with prefrontal, first superciliary, anterior preoculars, and second and third or third and fourth supralabials; two rows of preoculars variously divided but usually three in number, often four; scales of second row (nearest eye) smaller; a single elongate subocular sometimes broken up into two scales; two or three postoculars, first in contact with anterior supratemporal; four or five superciliaries above eye; presupratemporal wedged between last superciliary, first supratemporal, frontoparietal, and parietal; supratemporals 6-8; supralabials eight or nine, sixth and seventh or seventh and eighth larger than others in the series; ultimate supralabial small, no larger than temporal scales; temporals small, little larger than dorsal body scales; six to eight small scales border the anterior margin of the ear opening; mental roughly pentagonal; 5-7 enlarged infralabials; postmentals (sublabials) four or five, first pair meeting back of mental, second pair narrowly separated by a small scale, and third pair with three or four rows of gular scales between them; gular scales large, as large as temporals; 6-8 large central scales on gular fold.

Scales on dorsal portion of body and limbs small, granular; dorsal scales in 30 (32.2) 34 longitudinal rows; ventral scales large, quadrate, in 29 (30.2) 32 transverse rows; scales on anterior surface of limbs somewhat enlarged; lamellae on underside of fourth toe 15 (16.8) 18; femoral pores 5-9; preanals usually four, sometimes two or three; tail ringed with flattened rectangular shields.

Coloration.—There is apparently but a single color phase in this subspecies. *Xantusia v. vigilis* has two distinct color phases while occasional variants in *X. v. wigginsi* resemble the uniform color phase of the typical form.

The head above is a uniform gray-brown with a few scattered, dark punctations. A narrow, light line, strongly demarked by a series of fused dark spots along its lower border, originates at the eye or first superciliary and proceeds posteriorly along the upper portion of the supratemporals and the lower margin of the adjoining enlarged head plates onto the neck. In the

smallest specimen (MVZ 45371), a juvenile, these lines are more or less evident past mid-body where they become fainter for a short distance until they join a similar pair of stripes running forward from the tail. The pineal eye is light, located under the darkened interparietal plate. The sides of the head are somewhat darker than the top; a number of large, dark spots are present, the labials in particular are so marked. The gular region is somewhat suffused with dark flecks medially; laterally they are heavily marked with dark blotches and punctations. The median area of the region between the gular fold and the posterior pregular fold is light.

The dorsum and back of the limbs are of a uniform brownish-gray upon which are interspersed at wide intervals large, dark spots. These spots are more concentrated laterally so that some specimens in which the middorsal area is unspotted appear to possess a central dorsal stripe. The belly and underside of the limbs are light with a few dark, scattered punctations. The lateral pattern extends onto the first two or three ventral scale rows.

The tail presents much the same basic concentration of pigment into large spots as is found on the dorsum. The ground color is lighter and the enlarged spots tend to be located on the posterior margin of the caudal scales. In some specimens a pair of light stripes originates on the back above the insertion of the hind-limbs and runs the length of the tail. The median ventral portion of the tail is light, margins are heavily marked with dark spots and punctations.

Discussion.—As already pointed out by Schmidt and emphasized by Klauber, the divided frontal of the holotype of *X. v. gilberti* is an anomaly. In all the other specimens of this form there is a single frontal. The type is also unique in having the frontonasal in contact with the frontal.

The small eye of *gilberti* has also been used to distinguish this form from typical *X. v. vigilis*. Examination of all Baja California *Xantusia vigilis* and a large series of specimens from the United States leaves the distinct impression that there is a north-south gradient in relative eye size. Material from the Mojave Desert of California appears to have the largest eyes while specimens from the Cape region have the smallest eyes. Unfortunately, there has also been a corresponding shortening and narrowing of the head. Consequently, little difference can be ascertained by a comparison of eye/head length, eye/head width, etc. ratios. Since no means of clearly showing this difference has been discovered, the character has not been utilized in this study.

Distribution.—The San Lucan night lizard probably occurs throughout the mountains of Cape San Lucas and northward into the Sierra Giganta. Three night lizards from near Pozo Grande on the western side of the Sierra Giganta are here referred to *X. v. gilberti*. They are atypical of the subspecies in coloration and appear to represent a population intermediate between this form and *X. v. wigginsi*. The coloration is much more intense than in either subspecies, with concentration of dark areas ventrally and on the throat. This pattern is best described as being a modification of the characteristic *wigginsi* pattern that has had the number of spots reduced and

the size and intensity of the spots increased. In these changes the tendency is toward the widely separated, large spots of *gilberti*. The ventral scales are in 31 transverse rows in all three examples, agreeing in this respect with typical *gilberti*. Tentatively these lizards may be considered intergrades between *X. v. wigginsi* and *X. v. gilberti* with decided tendencies toward the latter form.

Specimens examined.—DISTRITO DEL SUR: Sierra Laguna (MVZ 45370-71); La

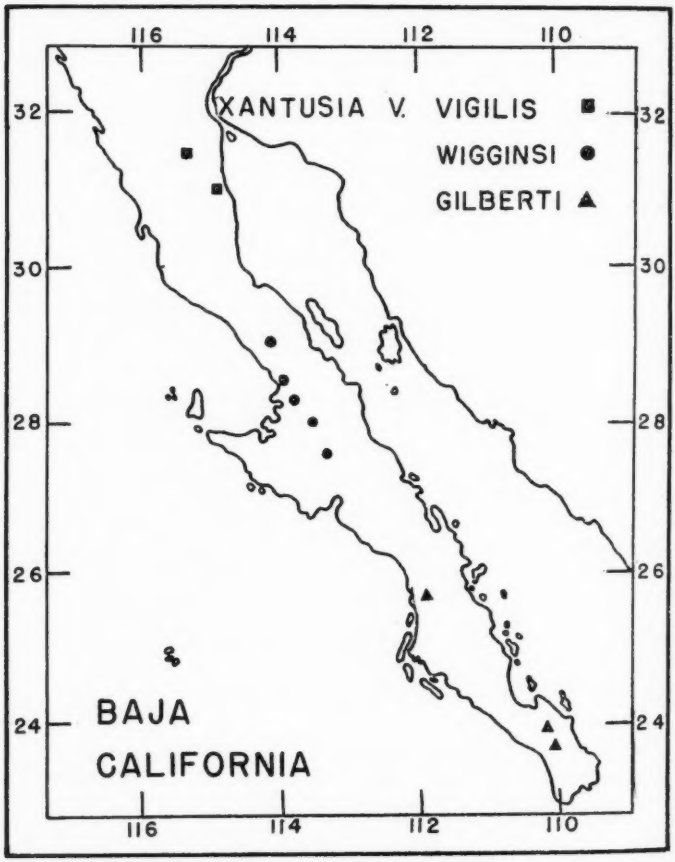

Fig. 1.—Principal localities from whose vicinity Baja California *Xantusia vigilis* have been obtained. Listed from north to south: Valle de Trinidad, San Felipe, Punta Prieta, Miller's Landing, Rancho Mesquital, El Arco, Los Angeles (rancho), Pozo Grande, San Francisquito and La Laguna.

Laguna, Sierra Laguna (USNM 37680; CHL 1892, 1921-25; KSN 536A, 567); San Francisquito, Sierra Laguna (CAS 401, holotype of *X. v. gilberti* Van Denburgh); 5.8 miles north of Pozo Grande (CHL 1817); 12.9 miles north of Pozo Grande (CHL 1816; KNS 448).

This form was named by Van Denburgh for his zoology professor, Dr. Charles Henry Gilbert of Stanford University. It is therefore with great pleasure that I name a new subspecies in honor of another Stanford biologist, Dr. Ira Loren Wiggins, Director of the Natural History Museum of Stanford University and Curator of the Dudley Herbarium, who collected the first examples of the new form and whose unfailing enthusiasm and energy have added many valuable specimens to Stanford's herpetological collections.

Xantusia vigilis wigginsi, new subspecies
Baja California Night Lizard

Holotype.—Natural History Museum of Stanford University 11564, taken in an arroyo 9 miles east of Miller's Landing, Distrito del Norte, Baja California, Mexico, by Drs. Ira L. Wiggins, H. M. Hill, and A. M. Vollmer, on October 29, 1946.

Diagnosis.—A subspecies of *X. vigilis* intermediate between the typical form and *X. v. gilberti*. Differs from the other forms as follows: (1) ventrals usually less than 29, 25 (27.4) 29; (2) dorsal pattern of numerous small, discrete spots, never fused to form blotches or lines; (3) tail with dark spots restricted to tips of scales.

General characteristics of holotype.—Normal *Xantusia* habitus; head wedge-shaped, snout rounded; nostrils not visible from above, well below canthus; eye moderate, round, lidless, a little more than halfway between anterior margin of ear opening and tip of snout; pupil vertically elliptical; ear opening elliptical, oblique; two pregular folds, anterior indistinct, running between ear openings; posterior discernible as a shade of difference in the size of gular scales, two or three scale rows anterior to gular fold; gular fold originating before and above forelimbs; occipital groove faintly evident, passing between openings just posterior to enlarged head plates.

Body elongate, somewhat depressed, narrowed at juncture of limbs; a distinct mid-dorsal groove running the length of the body and continuing for a third of the length of the tail; secondary grooves on either side of mid-dorsal less prominent; a lateral fold along each side between limbs; limbs moderate, overlapping when adpressed; tail round, somewhat flattened ventrally, tapering abruptly for last third of its length into a blunt point; peritoneum black.

Measurements of holotype.—All figures are in millimeters. Length overall 97.0; snout-vent length 38.0; tail 59.0. Head length, measured from tip of snout to anterior margin of ear opening, 8.5; shielded portion of head 9.0; rostral to first pregular fold 8.5; rostral to second pregular fold 11.5; rostral to gular fold 12.0. Head width 5.5; head depth 4.0. Diameter of eye 1.6; rostral to anterior margin of orbit 4.0; posterior margin of orbit to anterior margin of ear opening 3.5. Length of forelimb 10.0; length of hindlimb 13.0. Distance from base of fifth toe to tip of fourth toe, exclusive of claw, 4.5.

Squamation of holotype.—Rostral much broader than high, followed by enlarged head shields in this order: two internasals, a frontonasal, two pre-

frontals, a frontal, a pair of frontoparietals, a large interparietal separating two parietals, two occipitals separated posteriorly by a small azygous interoccipital; internasals in contact with rostral, postnasal, and frontonasal; frontonasal meeting internasals anteriorly, touching prefrontals, laterally in contact with postnasal and first loreal; prefrontals bordering anterior margin of frontal and separating it from frontonasal, in contact with first superciliary, on right side meeting second and third loreals, on left first and second; frontal bordered by prefrontals, frontoparietals, and two superciliaries; frontoparietals in contact with frontal, three superciliaries, parietal, interparietal, and presupratemporal; parietals separated by interparietal; four supratemporals, presupratemporal, and occipital meeting them; interparietal hexagonal, meeting occipitals, parietals and frontoparietals, pineal eye under posterior third; occipitals broadly in contact with interparietal and parietal; a small azygous interoccipital separating the occipitals for the posterior fourth of their length.

Nostril at juncture of rostral, internasal, postnasal, and first supralabial; postnasal in broad contact with first supralabial, barely touching second supralabial, meeting frontonasal; three loreals on right side, two on left; posterior loreal largest, in contact with third and fourth supralabials on right side, with second and third on left, and with anterior preoculars, first superciliary, and with preceding loreal; anterior loreal over second supralabials; median loreal, on right side only, touching second and third supralabials; two rows of preoculars, four on each side; suboculars (one on left, three on right) separating fourth, fifth, and sixth supralabials from eye; postoculars, two on left, three on right, same size as temporals, smaller than superciliaries; uppermost postocular meets lower border of last superciliary, on right, last superciliary and presupratemporal, on left; superciliaries 3-4; presupratemporal meeting last two superciliaries, first supratemporal, frontoparietal, and parietal; supratemporals eight, fourth largest, sixth divided horizontally on left side; supralabials 7-8, none noticeably enlarged, last rounded; temporals smaller than superciliaries, larger than dorsal body scales; seven or eight small scales border the anterior margin of the ear opening; mental triangular, separating first infralabials; enlarged infralabials five; four enlarged postmentals, last on left side partially divided by a horizontal suture, first pair in contact, second pair separated by an elongate scale, third pair separated by two rows of gulars, anteriorly by four, posteriorly by six scales; gular scales as large as temporals, 14 rows between pregular folds, two or three rows between posterior pregular fold and gular fold; seven enlarged scales on gular fold, median scale longest.

The back, sides, and limbs are covered by small circular scales. There are 34 longitudinal dorsal scale rows at mid-body. Between the enlarged head plates and the origin of the hind limbs there are 97 transverse rows. One head length at mid-body includes 27 transverse rows of scales. The underside is covered by enlarged rectangular plates in 27 transverse rows, followed by two pairs of preanal scales. There are 12 longitudinal rows of ventrals at mid-body, the ultimate row on each side rounded. The scales on the upper limbs are the same size as the dorsals except for three rows of slightly enlarged scales on the anterior surface. The lower limbs have three large plate-like

scales on antero-ventral surface of femur and lower arm. The lamellae under the fourth finger are 14-14, under the fourth toe 20-18, in two rows. There are 6-6 femoral pores. A number of minute granules border the posterior margin of anus. The tail is sheathed by 95 rings of flattened, rectangular scales.

Coloration of holotype.—The head is uniformly grayish-brown, except for a pair of light stripes that originates at the eye and pass along supratemporals and the lower portions of the parietals and occipitals. These stripes are bordered above and below by dark punctations, the lower ones most intense. The scales on the head are marked with brownish punctations. The interparietals are brownish, the pineal eye gray. Scales between the eye and rostral are marked with dark flecks and spots. The lower edges of the labials are suffused with dark flecks. The gulars are light, flecked with dark punctations, particularly laterally.

The dorsum and limbs are predominantly light gray-brown with numerous scattered dark, brown spots. These spots are not in contact to form blotches or lines as in *X. v. vigilis* or never so few or large as in *X. v. gilberti;* the spots are most numerous laterally.

The ventrum is light, the marginal two or three rows of ventral scales flecked with dark markings; anal region light.

The tail is lighter than the body, with numerous dark blotches on the posterior margins of the scales. Ventrally it is heavily suffused with dark spots and punctations.

Variation in paratypes.—All specimens of this race have been utilized in the following discussion. Ranges and averages are based on the holotype and 34 paratypes. Five specimens under 30.0 mm. in snout-vent length have been omitted when computing proportions.

The head and body in all specimens present the same general morphology described for the holotype. In some gravid females the body is more robust and the lateral folds are not present.

Configuration of the enlarged head shields is standard in all specimens, the holotype being unique in the occurrence of an azygous interoccipital. The scales on the side of the head are subject to considerable variation. There are usually two loreals, the posterior largest. The preoculars number from two to six but are basically four in number. The subocular is elongate, often broken into two or three small scales. The postoculars vary from 2 to 4. The presupratemporal is single. The supratemporals are usually seven, occasionally six or eight. The superciliaries vary from 3 to usually four. The supralabials are 7-9, usually eight, last one or two small. The enlarged infralabials from 4 to 6, usually 5.

Scales across dorsum 31 (34.3) 38; longitudinal ventral series 12 in all cases; transverse ventrals (excluding preanals) 25 (27.4) 29; lamellae under the fourth toe 16 (17.9) 20; femoral pores 4-9, usually six, sometimes absent.

Snout-vent length 22.0 (33.9) 44.0 mm.; head length into snout-vent length 4.1 (4.6) 5.3; head width into head length 1.2 (1.4) 1.8; head depth into head length 1.5 (1.9) 2.1; the tail usually a bit longer than the body.

The coloration in the paratypes is fundamentally the same as in the holotype. All specimens are considerably lighter in general color and the spots are not so intense as in typical *vigilis* or *gilberti*. Southern examples show a marked tendency toward a reduction in number and an increase in intensity of color of spots. Several lizards from the extreme northern part of the range of *wigginsi* exhibit a pattern closely approaching that of *X. v. vigilis*. One specimen has a dorsal pattern very similar to that of San Pedro Mártir examples. Several others lack spots all together on the dorsum and legs, resembling rather closely the uniform color phase of *X. v. vigilis*. All of these specimens have the tail spots restricted to the terminal portion of the

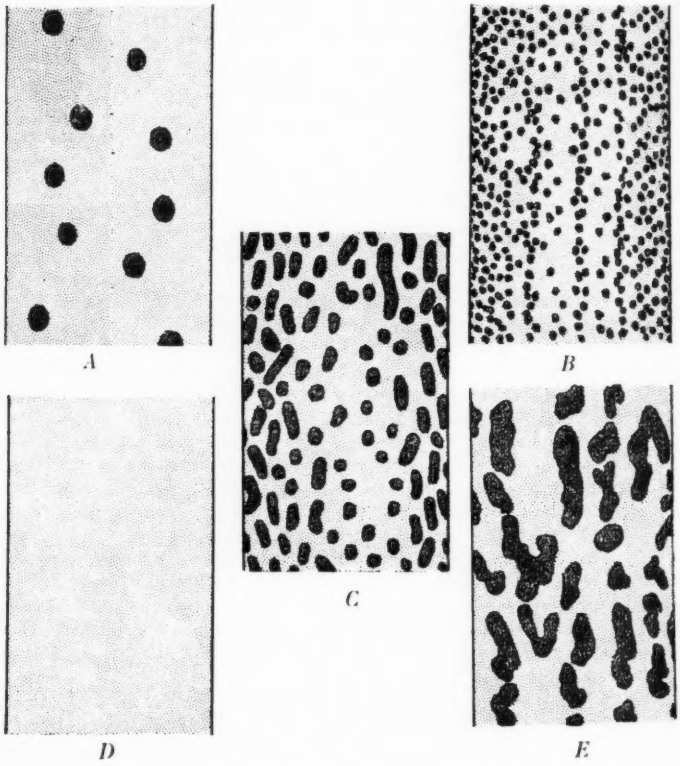

Fig. 2.—Dorsal color patterns of Baja California *Xanusia vigilis*. A. *X. v. gilberti*. B. *X. v. wigginsi*. C. *X. v. wigginsi-X. v. gilberti* intergrades from Pozo Grande. D. Uniform color phase which occurs in *X. v. wigginsi* and *X. v. vigilis*. E. *X. v. vigilis*.

scale while in typical *vigilis* the spots occupy the complete scale.

In a number of examples the light stripes that begin on the head continue backward for some distance onto the body. These stripes are further demarked by a concentration of dorsal spotting above and below, which persists some distance back of the point at which the stripes grade into the body color. In some examples this spotting gives the appearance of lines running the length of the back.

Most specimens have the gular region light, particularly from the gular fold to the first pregular fold. Some are similar to the type in having the gular region relatively heavily suffused with dark punctations. The figure of the dorsal pattern of this form somewhat overemphasizes the number and extent of the dorsal spots in *X. v. wigginsi.*

Distribution.—This form is known from central Baja California south of the Sierra San Pedro Mártir and north of the Sierra Giganta, exclusive of the Vizcaino Desert. Intergradation with *X. v. gilberti* has been discussed under that subspecies. Southern examples of *X. v. wigginsi* show decided tendencies toward the San Lucan form in the nature of the dorsal pattern.

A gene flow between typical *X. v. vigilis* and *X. v. wigginsi* remains to be demonstrated. A single specimen from near Rosario seems to be nearer to *wigginsi* than to the northern form. The spots, however, are darker and in some instances are lined up to form blotches. The caudal blotches are larger, and the general coloration is reminiscent of faded examples of *X. v. vigilis.* This lizard probably represents an intergrading population between *wigginsi* and *vigilis.* Other such populations are to be expected somewhere near the 30th parallel at the southern end of the Sierra San Pedro Mártir.

Specimens examined.—DISTRITO DEL SUR: 14.9 miles north of Los Angeles (CHL 1711-13); 14.9 miles south of El Arco (CHL 1209). DISTRITO DEL NORTE: 10 miles southeast of Rancho Mesquital (CHL 1206; KNS 334); summit of mesa south of Rancho Mesquital, altitude 310 meters (SU 11566); north slope of mesa at Rancho Mesquital, altitude 110 meters (SU 11565); 3.2 miles northwest of Rancho Mesquital (CHL 1702-05; KSN 332); 9 miles east of Miller's Landing (SU 11559-64); 7 miles east of Miller's Landing (SU 11558); 18 miles south of Punta Prieta (SU 11556-57); 12 miles south of Punta Prieta (SU 11549-55); 2.5 miles south of Punta Prieta (SU 11548); 23.5 miles north of Punta Prieta (CHL 1681-83; KSN 314-14); 0.5 miles west of Rosario (LMK 41048). All these examples with the exception of the Rosario specimen are paratypes of the new form.

XANTUSIA VIGILIS VIGILIS Baird

Desert Night Lizard

Xantusia vigilis Baird 1859, p. 255 (original description).

Holotype.—United States National Museum 3063, taken at Fort Tejon, Kern County, California, by John Xantus.

Illustrations.—Cope (1900, fig. 97); Van Denburgh (1922, pl. 49); Smith (1946, p. 331).

Diagnosis.—Readily distinguishable from the other subspecies by: (1) ventrals usually in less than 29 transverse rows, 25 (27.4) 29; (2) dorsal blotches formed by fusion of several dark spots; a second color phase uniformly grayish-brown with no evidence of spots on dorsum or tail; (3) tail spots occupy whole scale, either arranged to form lines or completely lacking.

Discussion.—There is some indication that the northern populations here referred to *X. v. vigilis* may contain two or more forms worthy of nomenclatorial recognition. No attempt has been made to evaluate material from outside of Baja California in the present study, a detailed discussion of United States lizards of this species being reserved for a subsequent paper.

Distribution.—The high deserts and arid mountain areas from Washington County, Utah south and east through northwestern Arizona and southern Nevada to the Inyo Mountains, Inyo County, California; south throughout the Mojave Desert, low altitudes of the San Bernardino and San Jacinto Mountains, along the eastern slope of the coast range into the Sierra San Pedro Mártir of Baja California; and northward through the intercoastal ranges from Ventura and Kern Counties to San Benito County, California. Also, a single specimen has been recorded by Slevin (1949, p. 148) from near San Luis in extreme northwestern Sonora.

An example in the collection of Dr. L. M. Klauber of San Diego (LMK 20121) is reputedly from Santa Catalina Island off the coast of southern California. The species probably does not occur there naturally. It is likely that this specimen was either introduced there or the locality is in error.

Stebbins (1948, p. 98) presents a map illustrating all previously reported localities for this subspecies.

Specimens examined from Baja California.—DISTRITO DEL NORTE: San Felipe Bay (USNM 37379); Aquajita Spring, west end of San Matias Pass, Sierra San Pedro Mártir (SDSNH 16919); San Matias Pass near Diablito, Valle de Trinidad, Sierra San Pedro Mártir (SDSNH 16899-16918); Valle de Trinidad, Sierra San Pedro Mártir (SDSNH 16893-98).

RELATIONSHIPS

Xantusia vigilis is apparently the most recently evolved member of the genus, and sufficient time has hardly elapsed for more than trivial differences to arise between the various sub-populations. Of the three subspecies described above, *X. v. vigilis* would seem to be the form most nearly approaching the primitive progenitor of the species. The pattern is of irregular blotches in this form, resembling the reticulate pattern that represents the basic, unspecialized color pattern of the genus.

The ancestral *vigilis* stock apparently entered Baja California rather recently and rapidly moved southward to the tip of the peninsula. The changes in color pattern which culminated in the distinctive coloration of the subspecies at the present time seem to have occurred during this period. The primitive pattern appears to have been retained by the northerly populations and modified in the Baja California lizards. The pattern of the central race, *X. v. wigginsi,* is best explained in terms of a reduction in the number and degree of expansion of the chromatophores. This reduction converted the primitive, blotched pattern of *X. v. vigilis,* or its ancestor, into a series of smaller, lighter, and more widely dispersed spots.

The coloration of *X. v. gilberti* is merely an increase in the tendency for the reduction in number of expanded chromatophores. However, as the spots became more widely separated the chromatophores became greatly expanded

so that while this form has many fewer spots than *X. v. wigginsi* they are much larger and darker than the spots in the latter subspecies. Some time after these changes in color pattern were initiated the Cape population appears to have become isolated, probably by the separation of the San Lucan region from the rest of the peninsula during the Pleistocene. During this time a reduction in the number of transverse ventrals took place in the mainland races while a larger, more primitive number was maintained by the Cape form. The period of separation does not appear to have been of long enough duration to have prevented interbreeding between *X. v. gilberti* and *X. v. wigginsi* when the isolating barrier was removed.

Briefly, the evolution of *wigginsi* seems to have been directly from a *vigilis*-like prototype. *X. v. gilberti* in turn arose more or less directly from a population similar to present day *wigginsi*. The San Lucan form may be considered as being most closely related to *wigginsi*. The central Baja California form, intermediate between *gilberti* and typical *vigilis* in both coloration and geographical position, seems to be more nearly allied in most respects to the latter subspecies.

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Particularly appreciated are the efforts of the collectors of Baja California *Xantusia*, Dr. Ira L. Wiggins, Mr. Charles H. Lowe, Jr., and Mr. Kenneth S. Norris, without whose work this study could never have been undertaken.

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The Hair of California Mammals with Keys to the Dorsal Guard Hairs of California Mammals

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It has long been recognized that hairs are as characteristic of mammals as are the glands which give the class its name. When hairs do not appear in the adult animal, as in Odontoceti, they are at least present in the embryo. They may be confined, as in Mysticeti, to the region of the nares, or they may appear over the entire body, as in the Reindeer, in which even the usually bare mammalian snout is hairy. In recognition of this characteristic presence of hair it was at one time proposed that the class should be named Trichozoa or Pilifera.

In recent years significant investigations on hair have been few, the latest contribution of note being that of Hamilton et al. (1951). In the latter part of the nineteenth century and early part of the twentieth century more extensive research was accomplished. However, merely 47 of the more than 3000 references in the possession of the author deal primarily with hair as a means of classification or identification, and the majority of these are anthropological studies on human hair. Only 17 concern themselves wholly or in sizeable part with the problem of hair of mammals other than man. With respect, then, to its systematic usefulness little research on hair has been done, and the taxonomic value of hair is a subject on which all authors have not agreed. Cole (1924: 120) and Nason (1948: 358), studying bats, both came to the conclusion that hair is of little use in identification. Mathiak (1938), Williams (1938), and Brown (1942) all arrived at the opposite conclusion, and prepared aids for identifying certain mammals on the basis of hair alone. With this latter group the present author is in complete agreement. The ability to make positive identification of mammalian hair is of great value in fields such as criminology and paleontology and particularly in the field of food habits studies. Fortunately hair is a relatively durable feature, and a high percentage of the shafts recovered from the digestive tracts of birds and mammals are capable of being used for the purpose of making identification.

Hair Structure

The hair shaft is a highly keratinized column lacking both nerves and blood vessels. The follicle is formed embryologically as an ectodermal invagination of cells from the malpighian layer of the epidermis. This invagination splits, and cells proliferating from the ectodermal base of the follicle, and nourished by a deeper-lying dermal papilla, move peripherally as the hair shaft proper (Danforth, 1925: 23). As the hairs move outward from the basal bulb, the cells become more highly keratinized and tend to lose their individual identity.

A typical hair consists of three parts:

The outermost layer, termed the cuticle, is composed of thin, usually unpigmented cells without nuclei. It surrounds the hair's central core as bark surrounds a tree trunk. The varying patterns formed by these cells have been classified by Hausman (1930: 259) into two main categories, coronal and imbricate. The coronal scales resemble flared drinking glasses stacked one inside the other (Fig. 4). The imbricate scales are arranged like shingles on a roof and vary in form from a proximo-distally flattened shape through various stages of attenuation to an elongate one.

The next layer, the cortex, is composed of closely packed fusiform cells which may or may not bear pigment. The cortical layer varies greatly in thickness, sometimes comprising the entire central core of the shaft, as in the order Chiroptera (Figs. 3, 4) or the family Phocidae (Fig. 6), and sometimes appearing reduced, as in the genus *Odocoileus* (Fig. 13). In the various mammalian genera one may observe innumerable intermediate stages between these extremes. Occasionally the cortex contains small air pockets termed fusi, which also are of value in classifying hairs.

The central part of the hair, the medulla, is composed of rather loosely packed cuboidal cells varying in pigment content. Air frequently is present and serves to distort the appearance of the keratinized structures as viewed under the microscope (Fig. 10). The medulla varies in size in inverse proportion to the size of the cortex, and it may occupy nearly the whole width of the shaft (Figs. 12, 13) or may be entirely absent (Figs. 3, 4, 6). In its simple form the medulla may appear as a fragmental column (Fig. 8), a discontinuous one (Fig. 2), a continuous one (Figs. 5, 12, 13) or in various other forms indicated by Hausman (1930: 259). It may also appear compounded (Figs. 9, 11), being composed of numbers of independent aggregations arranged in longitudinal, parallel rows. Mathiak (1938: 254) named this configuration the "rodent base," but this designation is inappropriate for the following reasons: First, the compounding is not confined to rodents, but occurs in lagomorphs as well and is even expressed weakly in certain insectivores and mustelids. Secondly, the phenomenon is not confined to the basal region of the hair, but may occur along the entire shaft length. In fact it is not uncommon to find the compounding most pronounced in the distal portion of the shaft, the basal configuration being a simple one. Thirdly, the compounding is not present in all rodents. In view of these facts the term "compounded medulla" is preferable to "rodent base."

One explanation of the origin of the compounded medulla is that compounding is produced by the breaking up of what were originally continuous bands of pigment, as in *Zapus*, where transverse bands of pigment cross the medulla and break up basally to form individual aggregations. The second explanation, favored by the present author, is that the compounded medulla is the result of cortical invaginations into the medullary region into which granular pigments have been concentrated. It may be demonstrated that even the transverse bands such as appear in the genus *Zapus* are pigmented by what seem to be granules from the cortical region. However, further

work on the development of hair is necessary before the question can be finally resolved.

Examination of the pelages of many mammals indicates that two general types of hair are usually present; a larger, thicker, more highly pigmented shaft, termed "over hair" or "guard hair," and a smaller, narrower, usually less heavily pigmented shaft, termed "under fur." The distinction between the two types is largely arbitrary, a maximum size limit being set for the under fur hairs, above which all shafts are considered guard hairs. In some groups of mammals the differences between the two are clearly marked, as in the Felidae and Canidae, while in others, such as the Insectivora and Chiroptera, the intergradation is so fine and the differences so slight as to make such differentiation unwarranted. It is often possible, even in groups where the differences appear obvious, to locate a series of intergrading forms varying from the smallest of the under fur hairs to the largest of the guard hairs. In some forms, such as *Mirounga angustirostris*, no under fur hairs are readily apparent.

DISCUSSION

Two morphological entities, the pelage and the skull, are used for identifying mammals, though identification is possible in most cases solely on the basis of the pelage. The individual hairs which comprise a pelage serve to differentiate it from others in one of the following ways:

The hairs differ perceptibly in form, size, and pigmentation from those of other pelages.

The hairs are of the same general types as those on other pelages but are present in varying amounts or arrangements.

Both dissimilar hairs are present and similar hairs occurring in differing amounts or arrangements.

Just as the pelage as a whole is of value to the mammalian systematist, so the component parts, the individual hairs, possess characteristics of taxonomic importance. These characteristics, which enable us to identify different hair samples, fall into five general categories. Listed in order of their importance, they are as follows:

1. *General form and size.*—This is the most useful and, at the same time, the most easily used of all the categories. Not only the length and width of the hair is considered, but also the degree of tapering, the point at which such tapering begins, the presence of a spatulate tip or of strictures (Fig. 1), and other gross morphological characteristics.

To illustrate: Utilizing form alone it is possible without resorting to any further examination to identify hairs with strictures and spatulate tips as those of the order Insectivora. Using size alone, it is possible to identify shafts possessing an appropriate length and a diameter of 200 micra or more as those of the order Artiodactyla. And frequently, when form or size alone cannot reliably indicate a specific group, it at least serves to eliminate certain other groups from consideration. For example, a maximum length of 15 millimeters does not identify one particular group, but it does eliminate the

Felidae, the Canidae, many of the Mustelidae, and others from consideration.

It is thus possible, through familiarity with the gross characteristics of size and form peculiar to hairs of various groups to materially aid the identification process either by specifically indicating one group or by eliminating suspected groups from consideration.

2. *Type of medulla.*—Hausman (1930: 259) described and illustrated the various types of medullae and gave them names. With little modification his nomenclature has been used, with or without acknowledgment, in almost every paper dealing with hair morphology since the appearance of his work. His classification of medullae is the one followed in this paper.

A medulla is present, in one of its forms, in the guard hairs of all California mammals except those of the order Chiroptera (Figs. 3, 4) and the family Phocidae (Fig. 6). The type of medulla, the type and distribution of its pigment, its variation in diameter along the shaft, and the ratio of its diameter to the total width of the hair are all important in identification.

Many mammals can be either identified or eliminated from consideration on the basis of medullary characteristics. For example: The presence of a compound medulla automatically eliminates from consideration most mammals excepting the rodents (Figs. 9, 11); a medulla which occupies a major portion of the shaft diameter eliminates most aquatic forms (Fig. 8); and a highly vacuolated medulla is distinctly characteristic of the Felidae (Fig. 5).

3. *The cortex.*—The cortex usually lies between the central medullary core and the outer, sheathing layer of cuticular scales. The ratio of its width to the width of the medulla at different levels of the shaft provides a useful criterion for identification. Other considerations such as the presence of fusi may also be of value. To illustrate: Certain Artiodactyls (Fig. 13) have characteristically small cortical areas, while the aquatic mammals (Fig. 8) used in this study have wide cortical areas in proportion to the size of the medulla. The order Chiroptera (Figs. 3, 4) and the family Phocidae (Fig. 6) have cortical material occupying their entire shaft width. Fusi are present in large numbers in the cortex of the genus *Erethizon*.

4. *Pigmentation.*—Distribution, color, and type of pigment are the three major considerations in this category.

a. Distribution: Not only the presence of pigment in the medulla, cortex, and cuticular scales is important, but also the way in which the pigment is distributed along the length of the shaft. Many mammalian hairs present a banded appearance (Fig. 7) due to the presence of pigment in certain areas and its absence or reduction in others. The majority of banded shafts are dark at the tip, followed by a succession of light and dark bands. However, *Taxidea taxus neglecta,* the California Badger, has banded hairs which differ from the common pattern in being light in their distal 3 or 4 millimeters. In non-banded shafts the heaviest pigment concentration is usually in the distal areas, the basal parts being almost always lighter.

b. Color: The interpretation of color remains somewhat subjective in spite of color keys which have been published in order to eliminate this variation. Obvious color differences are of importance in identifying hair samples, but subtle shadings of color should generally be disregarded because of the danger of subjectivity in interpretation. Judging colors under the microscope is an unsatisfactory procedure due to the difficulty of standardizing the illumination for all the samples observed. Colors vary greatly according to the intensity of transmitted light, and may range in appearance from brown to black or from yellow to red under different amounts of illumination. Due to varying degrees of pigment concentration and varying thickness of the hairs, it has not been possible to standardize the illumination for all the samples and still be able to observe the necessary detail (in all the samples) to make accurate identification. It is also necessary to remember that the color of hair seen under the microscope may differ greatly from the color of the same hair observed macroscopically. For example, a "black" hair may be decidedly brown under the microscope, and a "white" hair may appear to have a black medulla. This latter phenomenon of the black-appearing medulla in a white hair is actually due to contained air.

A final reason for avoiding too great reliance on coloration for identification is the fact that hairs not only vary greatly in color over different parts of the pelage, but also vary with the season, the stage of molt, wear, fading, and many other conditions. All of these factors must be taken into consideration before color is used in identifying samples, and in view of these considerations latitude must be given the color interpretations in any paper on hair. However, in this study when color terms are used on a comparative basis, as in certain diagnoses made for the keys, the samples have been observed under as nearly equal conditions of illumination as possible. The color terms employed in these cases are those of Ridgway (1912). In other instances the terms employed are those in popular use.

c. Type of Pigment: All pigment is essentially granular, but can be classed for convenience as diffuse, granular, or aggregate. To illustrate: Diffuse yellow-orange pigment in shafts of suitable size suggests the family Felidae and at the same time eliminates other somewhat similar groups from consideration. Shafts with only granular pigments present suggest the family Phocidae, while parallel series of medullary pigment aggregations point to the rodents or lagomorphs.

5. *Cuticular scales.*—The types of scales have been mentioned earlier as classified by Hausman (1930: 259). An investigation by Müller (1939) resulted in a changed concept of the coronal scales from that of Hausman, but this represents the only important departure from his descriptions up to the present time.

One of the seemingly most objective features of the study of scales is the scale index, which is the quotient obtained by dividing the diameter of the hair into the greatest, exposed, proximo-distal scale length at the point at which the hair diameter was measured. Ideally, the proximo-distal scale

length should be the average of many scale measurements in the area of the diameter used. Unless precaution is observed to represent an accurate average, the scale index is likely to become a somewhat subjective criterion due to variability in the lengths of adjacent scales and variation in the diameter of the shaft. The main difficulty, however, in the use of cuticular scales for identification results from the constancy of the scale types. Hausman (1930: 262) pointed out that the scales bear a relationship to the shaft diameter and not to the systematic category considered. It is almost axiomatic that shafts with small diameters have large scale indices and that shafts with wide diameters have small indices. Little latitude exists in which to differentiate between the many wide shafts with their small scale indices and between the many small ones with their large indices.

There are a few cases in which the distinctive shape of the scales is of value in differentiating different groups from one another, such as in the family Molossidae. However, even such distinctive patterns serve only to differentiate between larger taxonomic groups. It is the opinion of this author that the cuticular scales not only employ time-consuming techniques for accurate study but are also the least valuable of all the features employed in the identification of hair.

MATERIALS AND METHODS

The scope of this study was limited to those mammals which occur within the boundaries of the State of California. Grinnell's *Review of the Recent Mammal Fauna of California* (1933) was used as a starting point in determining the mammals considered indigenous to the state. Investigations of subsequent literature, as well as museum collections, were then made to obtain information as to the present status of some of the mammals mentioned by Grinnell. Only two major groups of the 460 species and subspecies of California mammals listed by him were completely omitted. Because of the difficulty in obtaining materials, the Cetacea were not included. The Primates listed were likewise omitted, due to the extensive amount of work already done by anthropologists on human hair. Excluding these two orders, hair samples were obtained from all the California species except *Arctocephalus townsendi* and *Perognathus alticolus*. With these omissions and with nomenclatorial changes since publication by Grinnell, a total of 392 species and subspecies remained for study.

As the hairs of mammals vary widely in structure over different parts of the body, samples were removed from two areas on each pelage, the mid dorsum half way between the tip of the nose and the base of the tail, and the mid venter, also halfway between the tip of the nose and the base of the tail. Hairs from these two areas appear as characteristic as any others of the animal as a whole, and they also provide great pigmentary contrast with one another. Selection of samples from these exact locations was rigidly observed, as comparative studies in the past have been weakened by having samples collected from the pelage at random. However, if the animal was distinctly patterned, such as the skunks and chipmunks, additional samples were obtained from the different colored hairs.

The hairs used in this investigation were obtained almost exclusively from museum specimens. As hair does not change appreciably after the death of the animal, unless preserved in alcohol or exposed to sunlight for long periods of time, it is essentially the same in structure as that on living animals. It was the author's desire to obtain as nearly comparable samples as possible, and an attempt was made to avoid obviously worn or faded skins. However, in order to have completely comparable material it would be necessary to take the hairs from all the pelages at a time when they were at exactly the same stage, for example, just after the spring molt, and even with the facilities of large collections at hand this is not always possible The fact that all the samples used in this study were not taken during identical phases does introduce a variable in the comparative picture, but those having occasion to refer to this work will also be dealing with pelages in various stages of wear, bleaching, or replacement, and for their purposes it may be as well that a greater variety of phases are included in this study.

No general statement can be made as to the number of hairs that constitute an adequate sample for identification. It is possible to identify many animals, such as the antelope, beaver, and fur seal, by a single dorsal guard hair. However, the hairs of pocket mice, chipmunks, and various other mammals may necessitate a more detailed examination and require a greater number of representative hairs for positive recognition. In a few cases it may even be necessary to refer to a file of known comparative material before positive identification can be made.

The hairs were removed from the pelages in one of two ways. In the case of specimens possessing a tough skin, such as mustelids, canids, felids, etc., forceps were used to grasp a few hairs firmly at their base and to remove them by a quick, hard pull, which caused no perceptible damage either to them or to the skin. In forms with thinner skins, such as Chiroptera and Lagomorpha, a small-bladed Bard-Parker knife was used to cut the hairs from the skin at their point of emergence. As the hair bulb shows no characteristics of systematic significance, its presence was unnecessary for the purposes of this investigation. Moreover, the bulb is usually absent or badly distorted in hair samples requiring identification, such as those recovered for food habit studies, and therefore could rarely be of use anyway.

After being removed from the pelage, the hair samples were placed in numbered coin envelopes, and a corresponding card bearing all the available information about the specimen from which the hairs were taken was placed in a master card file. This system provides a quick and accurate reference whenever additional detail concerning the source of a given sample is desired.

Several techniques for preparing the hairs for microscopic examination were tested, but the following became the standard ones for this investigation: The hairs were soaked in carbon tetrachloride to remove extraneous oil and dirt, carbon tetrachloride being used in preference to ether-alcohol mixtures because it is not flammable. The cleaned hairs were allowed to dry and were then mounted in balsam without further treatment. Guard hairs and under

fur hairs were mounted on the same slide to conserve space and to permit easy comparison of the two without changing slides. No attempt was made to remove the air contained in the medulla, for the presence of air may almost be considered a structural entity (Fig. 10) and to remove it would be to remove a unit of possible value in identification. It is nearly always possible to find some sections of the shaft in which air is absent, and the descriptions of the central parts of the shaft can be made from these areas. When the removal of air is desired, for the purpose of observing the entire shaft, the technique of Eddy and Raring (1941: 168) or that mentioned by Steida (1910: 345) can be utilized.

Hairs mounted in balsam present an excellent picture of cortical and medullary relationships, pigmentation, and general form and pattern of the shaft, and at the same time provide the basis for measuring diameters and observing proportions. However, a different technique is required in order to permit accurate observation of the cuticular scales without their being obscured by structures within the shaft. After experimenting with several methods which used dyes or various deposits to emphasize scale patterns, the technique of Hardy and Plitt (1940) was found to be far superior and was used exclusively. This technique involves the use of a transparent thermoplastic film, manufactured by the Dow Chemical Company under the trade name "Ethocell" and available in varying degrees of thickness. The hairs to be examined are placed between two layers of plastic to form a "sandwich," and this is put between two wooden blocks, tightened by "C" clamps, and heated at 90 degrees centigrade for approximately 20 minutes. When the plastic "sandwich" is disassembled, the hairs can be brushed from the surface, leaving an accurate impression of the scale pattern. The impression may then be inverted and observed as a positive image.

Many temporary mounts in cedar wood oil were made during this investigation for the purpose of checking questionable points. The samples from which permanent mounts were made number in excess of 1000 and are kept on file by the author as prototypes of the hairs described. Together with a collection of scale impressions, they constitute the most complete file of hairs of California mammals in existence.

The instruments used in taking measurements for this study were a millimeter scale for checking length and an ocular micrometer for measuring width, and all readings were checked several times. Full use was made of all powers of the microscope, but most of the detail was observed with a 44X objective and a 10X ocular.

BASIS OF DESCRIPTIONS AND KEY CONSTRUCTION

The guard hairs of the dorsum were found to possess a greater number of differentiating characteristics than any other group of hairs and were consequently used as the basis for construction of the keys, but this fact does not preclude the keys' use in identifying hairs from other parts of the body. Hairs of the venter and other areas usually resemble the dorsal guard hairs

closely enough to be identified, in spite of variation in size, pigmentation and other less important characteristics.

The author's chief aim in the construction of the keys was to make them as objective as possible, and particularly to avoid any of the vague or technical comparative statements which make some keys impractical and valueless for anyone not already an expert in the field. The present keys may be employed by a person without extensive knowledge of trichology or one who does not have an extensive comparative collection at hand, although the value of comparative material can not be over-estimated. Emphasis was placed on measurements, since they can be so readily checked and verified. Pigmentation was minimized in the comparative statements for the reasons mentioned earlier, and expressions such as "more than," "less than," "slightly," etc., have been eliminated wherever possible unless they have definite points of reference.

The original keys on which this paper was based were assembled in 1948, and typewritten copies were sent to several investigators for use and comment. The response was gratifying and some of the suggestions have been incorporated into the present version. The keys were reported to be effective for similar genera and species outside California, and Miss Gretchen Sibley of the Los Angeles County Museum was able to identify certain Pleistocene mammals from the La Brea Tar Pits with their aid. It is the author's hope to follow the present keys, which have made possible the identification of hairs of all genera of California mammals and nearly all species, with ones which will prove of value in the identification of races.

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KEYS TO THE DORSAL GUARD HAIRS OF CALIFORNIA MAMMALS

Unless otherwise stated all measurements recorded in this paper are maximum ones. The use of maximum measurements both avoids the confusion caused by overlapping when averages are used and facilitates identification through quickly eliminating many possibilities from consideration. However, too rigid adherence to the maximal measurements and failure to allow for natural variation should be avoided. In the course of this investigation occasional hairs of obviously abnormal size were encountered and were excluded from consideration.

ARTIFICIAL KEY TO THE DORSAL GUARD HAIRS OF THE ORDERS AND FAMILIES OF CALIFORNIA MAMMALS

1. Hairs white along entire length; maximum length 65 millimeters; maximum width 98 micra ..... Marsupialia, Didelphiidae. *Didelphis virginiana*

1a. Hairs usually not white along entire length, or if so, less than 65 millimeters in length 2

2. Marked spatulate tips and strictures present (Fig. 1); no prominent compound medulla (Figs. 9, 11) present. Insectivora 3

2a. Shafts usually without marked spatulate tips and strictures; prominent compound medulla may be present 4

3. Medulla less than one third of maximum width (Fig. 2); shaft with maximum of nine strictures; length 13 millimeters or less ..... Talpidae (exclusive of the genus *Neürotrichus*)

3a. Medulla more than two thirds of total maximum width; shaft with a maximum of four strictures; length 10 millimeters or less ..... Soricidae (and also genus *Neürotrichus*)

4. Shafts without medulla (Figs. 3, 4); width less than 22 micra. . Chiroptera 5

4a. Shafts usually with medulla; if without a medulla the width is greater than 22 micra (Fig. 6) 7

5. Width 21 micra as a maximum; length 8 millimeters ..... Phyllostomidae

5a. Width usually less than 21 micra; if 21 micra, the length does not exceed 4 millimeters 6

6. Shafts without prominent opposite cuticular scales (Fig. 3) ..... Vespertilionidae

6a. Shafts with prominent opposite scales (Fig. 4) ..... Molossidae

7. Medulla usually compound (Figs. 9, 11) in whole or part (except in the families Castoridae, Erethizontidae, and Zapodidae). Rodentia. Lagomorpha 15

7a. Medulla usually lacking compound configuration 8

8. Maximum width usually less than 200 micra; if greater than 200 micra the length is less than 15 millimeters (Ursidae may resemble *Bison bison* in length and width, but has a medullary width which is one quarter of its total width. Certain canids may be differentiated by their banded shafts). Carnivora 9

8a. Maximum width usually more than 200 micra; if less than 200 micra the length is in excess of 25 millimeters (If the maximum width is about 107 micra as in *Bison bison*, the length is 60 millimeters as a maximum, with no banding present, and with the medulla occupying two thirds of the total width). Artiodactyla 25

9. Maximum length 60 millimeters or more, with the medulla about a quarter of the total width of the shaft ..... Ursidae

9a. Maximum length usually less than 60 millimeters, or, if more, the medulla is over half the width of the shaft 10

10. Medullary column one quarter of the width of the shaft or lacking; no spatulate tip; shafts 40 millimeters or less in maximum length 11

10a. Medullary column always present and over a quarter of the width of the shaft; shafts with medullae approximately a quarter of the width of the hair are present in hairs with somewhat spatulate tips; shafts more or less than 40 millimeters in maximum length 12

11. Medulla present ..... Otariidae

11a. Medulla absent ..... Phocidae (Fig. 6)

12. Medulla highly vacuolated in appearance; yellow-orange cortex may be apparent ..... Felidae (Fig. 5)

12a. Medulla lacking the prominent highly vacuolated appearance; yellow-orange cortex apparently lacking or only slightly developed 13

13. Shafts not banded, or, if banded, the distal area is white or weakly pigmented ..... Mustelidae

13a. Shafts banded with prominent black distal area 14

14. The light band proximal to the dark tip is less than 11 millimeters in length or, if greater than 11 millimeters, the maximum shaft length is 65 millimeters or more ..... Canidae

14a. The light band proximal to the dark tip is more than 11 millimeters in length; maximum length 50 millimeters or less ..... Procyonidae

15. Medulla divided into irregularly rectangular cells which may be outlined by pigment granules; medullary compounding usually weak ..... Leporidae (Fig. 12)

15a. No prominent division of the medullary substance into cells; medullary compounding usually well developed (Figs. 9, 11) 16

16. Maximum length to 110 millimeters; width to 405 micra ..... Erethizontidae. *Erethizon epixanthum*

16a. Maximum length to 50 millimeters; width to 190 micra 17

17. Medulla less than a third of the diameter of the shaft ..... Castoridae (Fig. 8)

17a. Medulla usually more than a third of the diameter of the shaft 18

18. Hairs usually crossed by two or three prominent and well marked dark bands (Fig. 7); if not, the length is in excess of 28 millimeters or the width reaches a maximum of 170 micra (except for the genus *Glaucomys*) ..... Sciuridae

18a. Hairs not crossed by two or three prominent and well marked dark bands; length less than 36 millimeters; width usually less than 157 micra 19

19. Maximum width in excess of 75 micra (except for *Mus musculus* which has a maximum width of 42 micra) 20

19a. Maximum width usually less than 75 micra (if greater than 75 micra (certain *Perognathus*) the medullary aggregations are either absent or in excess of six abreast as a maximum, or (*Sigmodon, Ondatra*) the distal cortical pigmentation is more restricted than in 20) 23

20. Medullary aggregations four to six abreast ..... Muridae

20a. Medullary aggregations absent or, if present, less than four abreast 21

21. No compound medulla apparent; maximum length 13 millimeters; maximum width 105 micra ..... Zapodidae

21a. Compound medulla present; maximum length in excess of 13 millimeters; maximum width less than 105 micra 22

22. Maximum length 17 millimeters; maximum width 78 micra; medullary aggregations two or three abreast ..... Ochotonidae (Fig. 11)

22a. Maximum length 25 millimeters; maximum width 81 micra; medullary aggregations two abreast ..... Aplodontiidae. *Aplodontia rufa*

23. Shaft almost uniform in diameter along its length; tapering abruptly at the ends; cortical granules usually along entire length of the shaft; maximum length 17 millimeters; maximum width 190 micra; medullary width 85 micra; medullary aggregations eight abreast as a maximum ..... Heteromyidae

23a. Shafts tapering; cortical granules confined to the distal part of the shaft; length greater or less than 17 millimeters; width less than 190 micra; medullary width usually less than 85 micra; medullary aggregations less than eight abreast as a maximum 24

24. Shaft moderately tapered, especially proximally; cortical granules confined to not more than the distal 3 millimeters; maximum length 13 millimeters; maximum width 60 micra; medullary width 56 micra; medullary aggregations six abreast as a maximum ..... Geomyidae

24a. Shaft highly tapering proximally; cortical granules confined to not more than the distal five millimeters; maximum length 35 millimeters; maximum width 111

micra; medullary width 85 micra; medullary aggregations five abreast as a maximum ..... Cricetidae
25. Maximum width 450 micra; diffuse orange colored tip ..... Antilocapridae
25a. Maximum width less than 450 micra; darkly colored tip 26
26. Tip colored by brown granules for three or four millimeters of its length, or the entire shaft black with a maximum width of 305 micra ..... Cervidae
26a. Tip colored by brown granules for two millimeters, or the entire shaft brown with a maximum width of 107 micra ..... Bovidae

ARTIFICIAL KEYS TO THE DORSAL GUARD HAIRS OF THE SPECIES OF CALIFORNIA MAMMALS

TALPIDAE (exclusive of *Neürotrichus*)

1. Medulla of the spatulate tip may be irregularly compounded by two rows of aggregations abreast 2
1a. Medulla of the spatulate tip always simple and discontinuous (Fig. 2) ..... *Scapanus latimanus*
2. Maximum length 11 millimeters; maximum width 42 micra ..... *Scapanus townsendii*
2a. Maximum length 13 millimeters; maximum width 56 micra ..... *Scapanus orarius*

SORICIDAE (including *Neürotrichus*)

1. Maximum width of the spatulate tip 21 micra ..... *Notiosorex crawfordii*
1a. Maximum width of the spatulate tip more than 21 micra 2
2. Spatulate tip well developed, frequently in excess of twice the proximal width of the shaft. *Sorex* 3
2a. Spatulate tip less well developed, scarcely 8 micra wider than the proximal width of the shaft ..... *Neürotrichus. Neürotrichus gibbsii*
3. Width of the spatulate tip more than 31 micra 4
3a. Width of the spatulate tip less than 31 micra 8
4. Maximum length 10 millimeters ..... *Sorex bendirii*
4a. Maximum length less than 10 millimeters 5
5. Maximum length 5 millimeters or less 6
5a. Maximum length more than 5 millimeters 7
6. Medullary pigmentation brown in distal part of spatulate tip, black proximally ..... *Sorex lyelli*
6a. Medulla colorless in distal part of spatulate tip, black proximally ..... *Sorex vagrans*
7. Medullary pigmentation in spatulate tip black ..... *Sorex trowbridgii* (Fig. 1)
7a. Medullary pigmentation absent in distal part of spatulate tip ..... *Sorex pacificus*
8. Length more than 6 millimeters ..... *Sorex tenellus*
8a. Length less than 6 millimeters 9
9. Maximum width less than 27 micra ..... *Sorex merriami*
9a. Maximum width more than 27 micra 10
10. Distal medullary part colorless ..... *Sorex obscurus*
10a. Distal medullary part black 11
11. Cortical pigment reddish brown ..... *Sorex palustris*
11a. Cortical pigment dark brown or black 12
12. Cortical granules brown; maximum length to 5 millimeters ..... *Sorex ornatus*
12a. Cortical granules black; maximum length to 4 millimeters ..... *Sorex sinuosus*

VESPERTILIONIDAE

1. Shaft colored distally by brown regularly spaced granules (Fig. 3); pronounced black or dark brown masses basally. *Myotis* 2
1a. Shaft darkly pigmented along entire length with an occasional slight colorless tip, or with light sections present in areas of varying length 6
2. Maximum length less than 8 millimeters 3
2a. Maximum length more than 8 millimeters 5
3. Basal black pigment masses sharply delimited from one another ..... *Myotis californicus*
3a. Basal black pigment masses joined by brown or black granules 4
4. Basal scale index 1.21 ..... *Myotis yumanensis*
4a. Basal scale index 2.00 ..... *Myotis lucifugus, M. subulatus, M. velifer, M. occultus*
5. Maximum length 9 millimeters ..... *Myotis volans*
5a. Maximum length more than 9 millimeters, but seldom in excess of 11 millimeters ..... *Myotis evotis* (Fig. 3), *Myotis thysanodes*
6. Hairs darkly pigmented along their entire length, or with only slight colorless tip 7
6a. Hairs with light sections present to varying portions of their length 9
7. Entire shaft black or dark brown with an occasional colorless tip ..... *Lasionycteris noctivagans*
7a. Entire shaft brown or with a basal banded or beaded appearance 8
8. Maximum length 8 millimeters; width to 14 micra ..... *Eptesicus fuscus*
8a. Maximum length 10 millimeters; width to 18 micra ..... *Euderma maculatum*
9. Maximum length less than 7 millimeters ..... *Pipistrellus hesperus*
9a. Maximum length more than 7 millimeters 10
10. Prominent black or dark brown masses basally. *Lasiurus* 11
10a. No prominent black or dark brown masses basally 12
11. Maximum length 10 millimeters; basal banding indistinct ..... *Lasiurus borealis*
11a. Maximum length 12 millimeters; basal banding distinct ..... *Lasiurus cinerea*
12. Maximum length to 10 millimeters; basal three-quarters of the shaft colored by brown granules ..... *Corynorhinus rafinesquii*
12a. Maximum length 8 millimeters; basal three-quarters of the shaft almost colorless ..... *Antrozus pallidus*

MOLOSSIDAE

1. Maximum length 4 millimeters ..... *Tadarida mexicana* (Fig. 4), *T. femorosacca, T. macrotis*
1a. Maximum length to 10 millimeters ..... *Eumops perotis*

URSIDAE

1. Maximum length 80 millimeters; maximum width seldom in excess of 100 micra ..... *Ursus americanus*
1a. Maximum length greater than 80 millimeters, reaching 110 millimeters; width to 150 micra. Grizzlies 2
2. Maximum length 85 millimeters; width to 150 micra ..... *Ursus tularensis*
2a. Maximum length 110 millimeters; width to 107 micra ..... *Ursus henshawi*

PROCYONIDAE

1. Maximum length 50 millimeters; maximum width 180 micra ..... *Procyon lotor*
1a. Maximum length 25 millimeters; width not in excess of 100 micra ..... *Bassariscus astutus*

MUSTELIDAE

1. Maximum length less than 15 millimeters 2
1a. Maximum length more than 15 millimeters 3
2. Maximum length 10 millimeters; medulla continuous distally ..... *Mustela erminea*
2a. Maximum length seldom more than 8 millimeters; medulla discontinuous distally ..... *Mustela frenata*
3. Dark shafts brown or banded along their entire length 4
3a. Dark shafts black along their entire length 10
4. Shafts prominently banded ..... *Taxidea taxus*
4a. Banding absent or indistinct 5
5. Maximum length more than 50 millimeters ..... *Gulo luscus*
5a. Maximum length less than 50 millimeters 6
6. Maximum length 40 millimeters 7
6a. Maximum length 31 millimeters 8
7. Maximum diameter less than 100 micra ..... *Martes pennanti*
7a. Maximum diameter more than 100 micra ..... *Martes caurina*
8. Maximum medullary width two-thirds of total maximum width ..... *Mustela vison*
8a. Maximum medullary width one-half or less of total maximum width 9
9. Distal spatulate tip three times the width of the stalk on which it is borne ..... *Lutra canadensis*
9a. Distal spatulate tip less than twice the width of the stalk on which it is borne ..... *Enhydra lutris*
10. Maximum length less than 40 millimeters ..... *Spilogale gracilis*
10a. Maximum length more than 40 millimeters ..... *Mephitis mephitis*

CANIDAE

1. Dark tip less than 6 millimeters in length. *Vulpes* 2
1a. Dark tip more than 6 millimeters in length 3
2. Maximum length 60 millimeters ..... *Vulpes fulva*
2a. Maximum length 50 millimeters ..... *Vulpes macrotis*
3. Proximal dark area less than 20 millimeters in length. *Urocyon* 4
3a. Proximal dark area more than 20 millimeters in length. *Canis* 5
4. Maximum length more than 55 millimeters; distal dark band to 25 millimeters in length ..... *Urocyon cinereoargenteus*
4a. Maximum length less than 50 millimeters; distal dark band to 7 millimeters in length ..... *Urocyon littoralis*
5. Maximum length 150 millimeters; width to 168 micra; distal dark band to 22 millimeters; distal light region to 36 millimeters ..... *Canis lupus*
5a. Maximum length less than 100 millimeters; width less than 150 micra; distal dark band to 23 millimeters; distal light region to 15 millimeters ..... *Canis latrans*

FELIDAE

1. Maximum length more than 30 millimeters; width less than 100 micra ..... *Lynx rufus*
1a. Maximum length less than 30 millimeters; width more than 100 micra as a maximum ..... *Felis concolor* (Fig. 5)

OTARIIDAE

1. Maximum length 10 millimeters ..... *Zalophus californianus*
1a. Maximum length more than 10 millimeters 2

2. Maximum length 20 millimeters ..... *Eumetopias jubata*
2a. Maximum length 40 millimeters ..... *Callorhinus alascanus*

PHOCIDAE

1. Maximum width more than 250 micra; color gray ..... *Mirounga angustirostris*
1a. Maximum width less than 230 micra; pigment absent or dark brown ..... *Phoca richardii* (Fig. 6)

SCIURIDAE

1. Maximum length more than 20 millimeters ..... *Marmota flaviventer*
1a. Maximum length less than 20 millimeters 2
2. Maximum width more than 70 micra 3
2a. Maximum width less than 70 micra 13
3. Hairs generally crossed by a maximum of two dark bands (Fig. 7); width generally more than 100 micra (if crossed by three dark bands the maximum width is always more than 100 micra). *Citellus* 4
3a. Hairs crossed by a maximum of three dark bands; maximum width less than 100 micra 12
4. Shafts with one distal light band 5
4a. Shafts with both a distal and proximal light band 8
5. Compound medulla prominent in the proximal part of the shaft ..... *Citellus beecheyi*
5a. Compound medulla indistinct or absent proximally 6
6. Distal dark band one millimeter in length ..... *Citellus tereticaudus*
6a. Distal dark band more than 1 millimeter in length 7
7. Distal dark band two millimeters in length ..... *Citellus beldingi*
7a. Distal dark band four millimeters in length ..... *Citellus lateralis*
8. Shafts crossed by two dark bands (Fig. 7) 9
8a. Shafts crossed by three dark bands 11
9. Maximum width more than 125 micra ..... *Citellus variegatus* (Fig. 7)
9a. Maximum width less than 125 micra 10
10. Maximum length 12 millimeters; width to 80 micra ..... *Citellus townsendii*
10a. Maximum length 10 millimeters; width to 90 micra ..... *Citellus mohavensis*
11. Maximum length 10 millimeters; width to 111 micra ..... *Citellus leucurus*
11a. Maximum length 13 millimeters; width to 115 micra ..... *Citellus nelsoni*
12. Distal dark tip less than 1 millimeter in length ..... *Tamiasciurus douglasii*
12a. Distal dark tip to 2 millimeters in length ..... *Sciurus griseus*
13. Maximum length 15 millimeters; shafts lacking well developed spatulate tip ..... *Glaucomys sabrinus*
13a. Maximum length 13 millimeters or less; distal area widened into a noticeable spatulate tip. *Eutamias* 14
14. Maximum length 13 millimeters; pigmentation absent or slight in distal light region ..... *Eutamias panamintinus*
14a. Maximum length less than 13 millimeters; pigmentation prominent in distal light region 15
15. Maximum width usually in excess of 50 micra 16
15a. Maximum width usually less than 50 micra 18
16. Distal dark band 1 millimeter long; width to 51 micra ..... *Eutamias alpinus*
16a. Distal dark band more than 1 millimeter long; width more than 51 micra 17
17. Distal dark band 2 millimeters long; width to 59 micra ..... *Eutamias townsendii*
17a. Distal dark band 3 millimeters long; width to 59 micra ..... *Eutamias quadrimaculatus*

18. Dark basal portion of the shaft usually colored by dull brown granules 19
18a. Dark basal portion of shaft usually black 22
19. Maximum width more than 38 micra; compound medulla faint or absent 20
19a. Maximum width less than 38 micra; compound medulla with two rows of aggregations abreast 21
20. Medullary pigmentation brown ..... *Eutamias amoenus*
20a. Medullary pigmentation reddish ..... *Eutamias quadrivittatus*
21. Maximum length 10 millimeters; width to 36 micra ..... *Eutamias sonomae*
21a. Maximum length 12 millimeters; width to 35 micra ..... *Eutamias speciosus*
Perognathus penicillatus
22. Maximum length over 10 millimeters or, if 10 millimeters width to 48 micra ..... *Eutamias merriami*
22a. Maximum length 10 millimeters; width to 40 micra ..... *Eutamias minimus*

GEOMYIDAE

1. Maximum length 13 millimeters ..... *Thomomys townsendi*
1a. Maximum length less than 13 millimeters 2
2. Maximum length 9 millimeters; cortical granules extending along the distal 3 millimeters of the shaft ..... *Thomomys talpoides*
2a. Maximum length variable, but over nine millimeters if the cortical granules occur along the distal 3 millimeters of the shaft 3
3. Maximum length 10 millimeters; medullary aggregations 3 or 4 abreast; medulla brown distally ..... *Thomomys monticola*
3a. Maximum length variable; medullary aggregations three or more abreast; (if the length is 10 millimeters and the aggregations three abreast, the medullary pigment is yellow brown) ..... *Thomomys bottae*

HETEROMYIDAE

1. Maximum length usually less than 12 millimeters; if 12 millimeters in length the width is 60 micra or more. *Perognathus* 2
1a. Maximum length usually more than 12 millimeters; if 12 millimeters the width is less than 60 micra 12
2. Maximum length more than 9 millimeters 3
2a. Maximum length less than 9 millimeters 10
3. Maximum length less than 12 millimeters 4
3a. Maximum length to 12 millimeters 5
4. Maximum length to 11 millimeters 6
4a. Maximum length to 10 millimeters 7
5. Cortical granules present along entire length of the non-banded shaft; medullary aggregations 8 abreast as a maximum ..... *Perognathus formosus*
5a. Cortical granules confined to the distal 3 millimeters of the length of the shaft; medullary aggregations 7 abreast as a maximum ..... *Perognathus longimembris* (ssp. *longimembris*)
6. Maximum width to 82 micra; medulla to 78 micra; medullary aggregations to 7 abreast ..... *Perognathus baileyi*
6a. Maximum width to 48 micra; medulla to 44 micra; medullary aggregations to 3 abreast ..... *Perognathus xanthonotus*
7. Prominent compound medulla with medullary aggregations to 6 abreast .....
7a. Medullary compounding not prominent; medulla crossed by transverse bands 8
8. Maximum width 85 micra ..... *Perognathus californicus*

8a. Maximum width more than 100 micra 9
9. Maximum width to 116 micra ..... *Perognathus fallax*
9a. Maximum width to 190 micra ..... *Perognathus spinatus*
10. Light colored medullary aggregations form a distal light band 1 millimeter in length ..... *Perognathus parvus*
10a. Light colored medullary aggregations form a distal light band more than 1 millimeter in length 11
11. Light region of banded shafts usually less than 3 millimeters in length; if up to 4 millimeters, the width of the shaft is less than 42 micra .... *Perognathus longimembris*
11a. Light region 3 millimeters or more in length; shafts 45-47 micra wide as a maximum ..... *Perognathus inornatus*
12. Basal dark medullary aggregations concave medially, convex laterally, and placed in a spirally arranged pattern ..... *Microdipodops megacephalus* (Fig. 9)
12a. Basal dark medullary aggregations neither concave nor convex, located in individual invaginations in the medullary substance 13
13. Width 47 micra or more as a maximum; maximum length 15 millimeters or more; maximum medullary width 52 micra 14
13a. Width usually 46 micra or less; if more than 46 micra, either the length is less than 15 millimeters, or the medullary width is 45 micra or less 16
14. Distal 2 millimeters darkly colored by cortical pigmentation ..... *Dipodomys microps*
14a. Distal 3 or 4 millimeters darkly colored by cortical pigmentation 15
15. Distal three millimeters darkly colored by cortical pigmentation ..... *Dipodomys panamintinus*
15a. Distal four millimeters darkly colored by cortical pigmentation .... *Dipodomys venustus*
16. Maximum length 17 millimeters ..... *Dipodomys elephantinus*
16a. Maximum length less than 17 millimeters 17
17. Maximum length 15 millimeters; width to 45 micra 18
17a. Maximum length usually less than 15 millimeters; if 15 millimeters the width is less than 45 micra 19
18. Medullary pigmentation absent in the distal two millimeters of the shaft immediately proximal to the distal dark fraction of a millimeter ..... *Dipodomys deserti*
18a. Medullary pigmentation black in the distal two millimeters of the shaft immediately proximal to the distal dark fraction of a millimeter ..... *Dipodomys heermanni* (ssp. *californicus* and *goldmani*)
19. Cortical granules prominent in the distal 6 millimeters of the shaft .... *Dipodomys agilis*
19a. Cortical granules prominent in less than the distal 6 millimeters of the shaft 20
20. Cortical granules pronounced in the distal two millimeters of the shaft ..... *Dipodomys ordii*
20a. Cortical granules pronounced along more than the distal two millimeters of the shaft extending to 5 millimeters of its length 21
21. Cortical pigmentation prominent along the distal 3 millimeters of the shaft; maximum length 15 millimeters; maximum width more than 50 micra if the length is less than 15 millimeters 22
21a. Cortical pigmentation prominent along more than the distal 3 millimeters of the shaft; length usually less than 15 millimeters; width less than 50 micra 23
22. Maximum width 56 micra; maximum length 13 millimeters; medullary width to 48 micra ..... *Dipodomys leucogenys*
22a. Maximum width less than 56 micra; maximum length 15 millimeters; medullary width 45 micra or less ..... *Dipodomys nitratoides*
23. Cortical pigmentation prominent for four millimeters or more along the length of the shaft ..... *Dipodomys merriami*

23a. Cortical pigmentation prominent for less than four millimeters along the length of the shaft 24

24. Maximum length 13 millimeters; medullary aggregations to four abreast ..... *Dipodomys ingens*

24a. Maximum length 13 millimeters or less; if 13, medullary aggregations to three abreast ..... *Dipodomys heermani*

(The species *morroensis* and *stephensi* belong in this category and have a maximum length of 12 millimeters and a width to 35 micra. This will serve to distinguish them from all of the races of *heermani* except *tularensis* and *jolonensis* which also have these measurements).

CRICETIDAE

1. Maximum width more than 75 micra; length more than 20 millimeters 2

1a. Maximum width less than 75 micra; length less than 20 millimeters except in *Neotoma cinerea* (see below) 3

2. Medullary aggregations six abreast as a maximum ..... *Sigmodon hispidus*

2a. Medullary aggregations two abreast as a maximum ..... *Ondatra zibethica*

3. Strictures prominent along the length of the shaft. *Reithrodontomys* 4

3a. Strictures slightly developed or absent 5

4. Cortical pigmentation extending for 3 millimeters along the length of the shaft; medullary aggregations two abreast as a maximum; length to 12 millimeters ..... *Reithrodontomys halicoetes. Reithrodontomys raviventris*

4a. Cortical pigmentation confined to the distal half millimeter of the shaft; medullary aggregations to four abreast; length to 11 millimeters ..... *Reithrodontomys megalotis*

5. Spatulate tip absent; distal portion of the shaft gradually narrowing along its length. *Neotoma* 6

5a. Well developed spatulate tip present 9

6. Maximum length usually less than 13 millimeters ..... *Neotoma lepida*

6a. Maximum length more than 13 millimeters 7

7. Maximum length more than 20 millimeters ..... *Neotoma cinerea*

7a. Maximum length less than 20 millimeters 8

8. Maximum width less than 40 micra ..... *Neotoma fuscipes*

8a. Maximum width more than 40 micra ..... *Neotoma albigula*

9. Width less than 50 micra; length less than 15 millimeters 10

9a. Width usually more than 50 micra; if less, the length is at least 15 millimeters 18

10. Medullary width more than 36 micra ..... *Lagurus curtatus*

10a. Medullary width less than 36 micra 11

11. Medullary aggregations reduced in size proximally to the distal brown cortical region; length 10 millimeters or less; width less than 39 micra. *Onychomys* 12

11a. No appreciable diminution in size of medullary aggregations proximal to the distal brown area; length 9 millimeters or more; width 33 micra or more. *Peromyscus* 13

12. Maximum width usually 34 micra; maximum medullary width usually 30 micra; length 9-10 millimeters (If the maximum width measurements are smaller, the maximum length is 10 millimeters and the cortical granules are grayish-drab) ..... *Onychomys leucogaster*

12a. Maximum width usually less than 31 micra; maximum medullary width usually 22 micra; maximum length 9 millimeters (If the maximum width measurements are larger, the maximum length is less than 9 millimeters, or the cortical granules are brown) ..... *Onychomys torridus* (Figs. 10, 11)

13. Maximum length 14 millimeters ..... *Peromyscus truei*
13a. Maximum length less than 14 millimeters 14
14. Medullary aggregations to four abreast as a maximum 15
14a. Medullary aggregations less than four abreast as a maximum 17
15. Maximum length 13 millimeters; width to 34 micra. ..... *Peromyscus crinitus*
15a. Maximum length 10 millimeters; width to 43 micra 16
16. Width to 43 micra; medullary width to 34 micra ..... *Peromyscus eremicus*
16a. Width to 39 micra; medullary width to 32 micra ..... *Peromyscus maniculatus* (ssp. *clementis*)
17. Maximum width less than 34 micra ..... *Peromyscus californicus, Peromyscus boylii*
17a. Maximum width 34 micra or more ..... *Peromyscus maniculatus*
18. Maximum length 10 millimeters or less; width to 58 micra; medullary width to 47 micra. *Clethrionomys* 19
18a. Maximum length usually more than 10 millimeters; width to 71 micra; medullary width to 63 micra (If less than 10 millimeters in length the width is not more than 54 micra) 20
19. Smaller guard hairs dusky or slightly red; maximum length 10 millimeters; width to 58 micra; medullary width to 47 micra ..... *Clethrionomys mazama*
19a. Smaller guard hairs bright red; maximum length 8 millimeters; width to 56 micra; medullary width to 47 micra ..... *Clethrionomys californicus*
20. The width of the shaft in proportion to its length is greater than in 20a (e.g. L—11; W—60. L—13; W—65) except for the race *intermedius* in which it is narrower in proportion to its length. *Phenacomys* 21
20a. The width of the shaft is narrower in proportion to its length than in 20 (e.g. L—11; W—56. L—13; W—60). *Microtus* 23
21. Distal dark area two millimeters or less in length ..... *Phenacomys intermedius*
21a. Distal dark area three millimeters or more in length 22
22. Maximum length 12 millimeters ..... *Phenacomys albipes*
22a. Maximum length 13 millimeters ..... *Phenacomys longicaudus*
23. Maximum length usually less than 11 millimeters; if 11 millimeters, the width is 58 micra ..... *Microtus oregoni*
23a. Maximum length 14 millimeters; width greater than 56 micra; if 11 millimeters, the width is less than 58 micra 24
24. Distal brown tip 2 millimeters in length; medullary width to 47 micra ..... *Microtus montanus, Microtus townsendii*
24a. Distal brown tip to 5 millimeters in length; medullary width 47 micra or more 25
25. Hairs of similar length are less in width than those in 25a; if similar, the medullary width is proportionately greater than in 25a (e.g. L—13; W—58; MW—47. L—14; W—60; MW—54) ..... *Microtus longicaudus*
25a. Hairs of similar length are greater in width than those in 25; if similar, the medullary width is proportionately less than in 25 (e.g. L—13; W—60; MW—52. L—14; W—60; MW—47) ..... *Microtus californicus*

MURIDAE

1. Length less than 10 millimeters; width less than 45 micra ..... *Mus musculus*
1a. Length more than 10 millimeters; width more than 50 micra 2
2. Maximum width 77 micra ..... *Rattus norvegicus*
2a. Maximum width more than 85 micra ..... *Rattus rattus*

ZAPODIDAE

1. Maximum width 105 micra ..... *Zapus trinotatus, Zapus orarius*
1a. Maximum width 83 micra ..... *Zapus pacificus*

OCHOTONIDAE AND LEPORIDAE

1. Maximum length less than 20 millimeters. Ochotonidae ..... *Ochotona princeps*
1a. Maximum length more than 20 millimeters. Leporidae (Fig. 12) 2
2. Distal light region four millimeters in length; clear division into two light and two dark bands. *Lepus* 3
2a. Distal light region three millimeters or less in length; division into four bands indistinct in many cases. *Sylvilagus* 4
3. Medulla golden brown in the light areas of the shaft ..... *Lepus americanus*
3a. Medulla brown in the light areas of the shaft ..... *Lepus californicus* (Fig. 12), *Lepus townsendii*
4. Distal light band 2 millimeters in length ..... *Sylvilagus idahoensis*
4a. Distal light band three millimeters in length 5
5. Maximum width more than 100 micra ..... *Sylvilagus audubonii*
5a. Maximum width less than 100 micra 6
6. Dark distal tip to 5 millimeters in length ..... *Sylvilagus nuttallii*
6a. Dark distal tip less than 5 millimeters in length ..... *Sylvilagus bachmani*

CERVIDAE

1. Maximum width more than 300 micra. *Cervus* 2
1a. Maximum width less than 260 micra. *Odocoileus* (Fig. 13) 3
2. Maximum length to 40 millimeters ..... *Cervus roosevelti*
2a. Maximum length to 65 millimeters ..... *Cervus nannodes*
3. Maximum length to 50 millimeters; width to 255 micra ..... *Odocoileus virginiana*
3a. Maximum length to 28 millimeters; width less than 200 micra ..... *Odocoileus hemionus* (Fig. 13)

BOVIDAE

1. Maximum length more than 55 millimeters; shaft relatively straight; width less than 110 micra ..... *Bison bison*
1a. Maximum length less than 55 millimeters; shaft very kinky; maximum width more than 200 micra ..... *Ovis canadensis*

DESCRIPTION OF THE DORSAL GUARD HAIRS OF THE ORDERS AND FAMILIES OF CALIFORNIA MAMMALS

This section is presented to amplify, on the level of orders and families, the criteria for identification outlined in the keys and to elaborate on the differences between hairs which are difficult to distinguish from one another.

Order MARSUPIALIA—DIDELPHIIDAE

The dorsal guard hairs of the opossum are white along their entire length, which may be as great as 65 millimeters. The fine, woolly hairs of the underfur average 33 millimeters in length. The longer shafts of the underfur are black-tipped, while the shorter ones are white throughout their length. The hairs of the venter are shorter than those of the dorsum, the guard hairs averaging only 33 millimeters in length in this area.

White hairs are present also on the dorsal areas of mustelids and lagomorphs, and they occasionally appear on the pelages of other groups as an anomalous condition. However, the opossum shafts' relatively narrow width

(98 micra) in proportion to their length distinguishes them from the white hairs of other animals. Their medulla, the distal portion of which is of the intermediate type described by Hausman (1930: 268), provides an additional criterion for differentiation by its narrow width (75 micra) in relation to the total shaft width, which contrasts with the proportionately wider medulla present in the shafts of the mustelids. The white hairs of the lagomorphs can be distinguished from those of the opossum by a peculiar rectangular cell pattern in their medulla (Fig. 12).

Order INSECTIVORA

The order Insectivora is one of the easiest orders to identify on the basis of hair samples. A well developed spatulate tip, strictures along the length of the shaft (Fig. 1), and a lack of extensive medullary compounding (Fig. 2) serve to differentiate the insectivores from almost all other California mammals.

Hairs of the genus *Reithrodontomys* may possess both a spatulate tip and strictures but can be distinguished by their prominent compound medulla from shafts of the insectivores. The hairs of *Enhydra* and *Lutra* lack a compound medulla but have greater length and width than those of the insectivores.

Insectivore hairs rarely exceed 13 millimeters in length and may be as short as 3 millimeters. The broad distal portion of the shaft, known as the spatulate tip, is borne on a slender proximal stalk. Strictures occur along the shaft, and the hair bends at these strictures, giving the shaft a somewhat wavy appearance (Fig. 1). The areas between the strictures are referred to as interjacent areas or regions ("vermiculation," Jackson, 1915: 11). The shafts of both the dorsal surface and the ventral surface are relatively uniform in color, the dorsal hairs being slightly darker than those of the venter. The cortical pigment granules are concentrated distally, and the medulla is usually discontinuous, simple, and either brown or black.

TALPIDAE

With one exception, medullary width in the hairs of the moles is less than one-third the maximum width of the spatulate tip, which may reach 56 micra (Fig. 2). In hairs of the genus *Neürotrichus* it is greater than two-thirds of this width. On the basis of hair alone, the genus *Neürotrichus* is much more closely related to the Soricidae than to the Talpidae, resembling the former not only in the wider medullary region but also in length and in the number of strictures present along the length of its shafts. The maximum number of strictures in shafts of the Talpidae is 9, and the hairs are longer than those of the shrews, ranging up to 13 millimeters.

SORICIDAE

The hairs of the shrews differ from those of the moles in possessing a medullary width which is two-thirds or more of the total shaft width at the spatulate tip. The number of strictures along the shaft seldom exceeds 4, and

the hairs are smaller on the average than those of the moles, reaching a length of only 10 millimeters.

Order CHIROPTERA

The hairs of bats (Figs. 3, 4) are characterized by absence of a medulla and a width which does not exceed 21 micra, and these features serve to differentiate them from the guard hairs of all other California mammals. Hairs of members of the family Phocidae also lack a medulla (Fig. 6) but their width is far in excess of 21 micra.

In identifying the hairs of the Chiroptera it is sometimes necessary to utilize observation of scales and pigment to avoid confusing them with the under fur hairs of certain other groups. The cuticular scales are often prominent (Fig. 4), and they may project laterally as spines or extend only enough to give the shaft a beaded or nodose appearance. The lack of a medulla permits a rather unusual pigmentation, which may be in the form of transverse bands or, when correlated with the scale pattern, in the form of beads or nodules of pigment.

Nason (1948: 358-360) divides the hairs of bat pelages into two classes, guard hair and under fur. As mentioned before, the results of this study indicate that while the division is feasible for *Macrotus*, such fine intergradations exist between the largest and smallest hairs of the bat that no clearly separable categories are present and the separation is valueless.

PHYLLOSTOMIDAE

The family Phyllostomidae is represented within California by one species, *Macrotus californicus*. The only family with which its hairs might be confused, the Molossidae (Fig. 4), resembles it in possessing shafts with prominent spine-like extensions of the scales. However, hairs of the Phyllostomidae can be differentiated by their greater length (8 millimeters) or width (21 micra). *Macrotus* hairs are roughly twice the length of those of *Tadarida* and about one and one half times the width of those of *Eumops*.

VESPERTILIONIDAE

Hairs of the Vespertilionidae are not easily confused with those of the other two families of the order as they lack the prominent, lateral extensions of the cuticular scales (Fig. 3) which are so characteristic of the Phyllostomidae and Molossidae (Fig. 4).

MOLOSSIDAE

As has already been noted, the hairs of the Molossidae can be distinguished from those of the Vespertilionidae by their prominent, lateral, spine-like scales (Fig. 4). The Phyllostomidae possess the only hairs with which they might be confused. Shafts of the genus *Tadarida* can be distinguished by their short (usually not over 4 millimeters length), which is half the length of those of *Macrotus*. Hairs of the genus *Eumops* can be differentiated from those of *Macrotus* by a width of 14 micra, which is only two-thirds the width of 21 micra of the latter genus.

Order Carnivora

In contrast to hairs of the order previously mentioned, shafts of the carnivores usually show a marked division into guard hairs and under fur hairs. The prominent banding of many carnivore shafts may be used to advantage in identification, as in separating certain canids from forms such as *Bison bison*. Pigmentation is a somewhat unreliable criterion for identification of carnivore hairs due both to wide variation among the various members of the order and to pronounced seasonal changes, which may turn a pelage from brown to white, or vice versa. Guard hairs of carnivores can be distinguished from those of the marsupials either by their shorter length, greater proportionate width, lessened cortical area, or absence of an intermediate medullary pattern, as well as by the presence of pigment. They differ from the hairs of the Insectivora in lacking prominent strictures and, in most cases, spatulate tips. Presence of a medulla or a greater diameter distinguishes them from shafts of the Chiroptera, and their simple medulla easily differentiates them from those of most of the rodents, which usually possess a prominent, compound medulla. The simple medulla also serves to distinguish them from hairs of the lagomorphs, as does their lack of the rectangular cell pattern present in the medulla of lagomorph shafts. Only hairs of the larger carnivores could be confused with those of the order Artiodactyla, and here differentiation can be made on the basis of their smaller width, or their lack of a honeycombed medulla (Fig. 13), or their lessened proportionate medullary width.

Brown (1942) investigated the hairs of carnivora and recorded maximal measurements which in almost every instance exceed the maxima presented here. Since no mention is made of the areas from which his hair samples were taken, this discrepancy may be due to the use of hairs from different parts of the body, as neither the mid-dorsal nor mid-ventral hairs, on which this study is based, necessarily represent the maximum length or width attained by the hairs of a pelage.

Ursidae

Hairs of the Ursidae can be distinguished from those of other California carnivores on the basis of narrow medullary width (roughly one quarter of the total shaft width, e.g. 25 micra in a shaft 91 micra wide). The genera *Lutra, Enhydra,* and *Callorhinus* also have hairs with proportionately narrow medullae, but the shafts of the Ursidae are easily identified on the basis of their greater length (ranging to 110 millimeters), which is usually twice that attained by the other genera in question. Hairs of the Ursidae may be differentiated from those of the genus *Bison* by their smaller medullary width. The medullary width in *Bison* is two-thirds the total shaft width of 107 micra.

Procyonidae

The Procyonidae differ from the Ursidae in possessing hairs in which the medulla occupies over half of the shaft diameter, which may be as great as 180 micra. These hairs are similar to those of the Canidae in their banded appearance, but they can be distinguished by the greater length of the light band proximal to the dark, distal tip. Except for the genus *Canis* the light

band in hairs of the Canidae is less than 11 millimeters long, while in those of the Procyonidae it is more than 11 millimeters. Hairs of the Procyonidae contrast with those of the genus *Canis* in their smaller length, which is seldom in excess of 50 millimeters, while *Canis* hairs reach 150 millimeters. They can be distinguished from those of the Felidae by their lack of a vacuolated medulla (Fig. 5). They are differentiated from the hairs of the Otariidae, Phocidae, and most of the Mustelidae by their banded shafts, the few banded mustelid hairs being identifiable through a different pattern of banding which begins distally with a relatively light region instead of a prominent, dark one.

If a separate family designation were used for the ring-tailed cats, the Procyonidae would then be differentiated from the Bassariscidae on the basis of their longer and wider shafts.

MUSTELIDAE

The larger mustelid guard hairs resemble those of the Ursidae in length and width, but may be distinguished by their greater medullary width, which may exceed three-quarters of the shaft diameter (e.g. 129 micra in width in a hair 138 micra wide). They differ from those of the Felidae (Fig. 5) in lacking the extensive, diffuse, yellow-orange cortical pigmentation and the highly vacuolated medulla characteristic of the felids. They either have no banding, or, if banding is present, it begins distally with a light band or a poorly developed dark one instead of a prominent dark band, in contrast to the pattern of banding present in the families Canidae and Procyonidae. Most mustelid hairs are differentiated from those of the Otariidae by a relatively greater medullary width. The mustelid genera *Lutra* and *Enhydra* have narrow medullae but differ from Otariidae in having wider distal areas. They can be distinguished from the Phocidae by the presence of a medulla.

The length and width of mustelid hairs varies greatly (varying in length from less than 10 millimeters to more than 55 millimeters), and their coloration ranges from black and unbanded shafts to light, banded hairs such as those of *Taxidea*. The medulla is also variable, and may be absent, may occupy a sizeable portion of the shaft diameter, or, in *Spilogale*, may even appear compound.

CANIDAE

The prominent banding of the hairs of the Canidae serves to distinguish them from those of the Ursidae, Otariidae, Phocidae, and Mustelidae, the black distal band appearing in hairs of some of the mustelids but only weakly. Lack of a highly vacuolated medulla (Fig. 5) and the absence of a diffuse, yellow-orange color differentiates hairs of the Canidae from those of the Felidae. The Procyonidae possess the hairs most easily confused with those of the canids. However, in their hairs the light band proximal to the distal tip exceeds the maximum length of 11 millimeters attained by the same bands in the genera *Vulpes* and *Urocyon*. The genus *Canis* also possesses a band in excess of 11 millimeters in length but contrasts with the Procyonidae in having a total shaft length of 150 millimeters, as contrasted to 50 millimeters for the Procyonidae.

FELIDAE

Hairs of members of the family Felidae can be distinguished from those of other families within the order by the presence of a highly vacuolated medulla (Fig. 5) and a large amount of diffuse, yellow-orange cortical pigment. Their pronounced banding readily differentiates them from hairs of the Ursidae, Phocidae, Otariidae, and most of the Mustelidae. In those mustelid hairs which have a dark distal band it is so weakly developed as to permit distinction from the shafts of the felids. The hairs of the genus *Lynx* can be distinguished from the banded shafts of the Canidae and Procyonidae by a much weaker development of the second dark band.

OTARIIDAE

The shafts of the Otariidae are non-banded and thus can be quickly distinguished from those of the Canidae, Procyonidae, and Felidae. They differ from those of the Ursidae in having a length which does not exceed 40 millimeters. The presence of a medulla differentiates them from the Phocidae, but, as in most aquatic forms, the medulla is poorly developed. It is fragmental and occupies less than half the shaft diameter of 190 micra. This proportionately smaller medullary width and the fact that the shafts are relatively short and wide differentiates them from hairs of the mustelids. The only mustelid genera with which hairs of the eared seals might be confused are the genera *Enhydra* and *Lutra,* and these possess wide distal areas which are not evident in the shafts of the Otariidae.

PHOCIDAE

Most hairs of the Phocidae suffer broken distal ends, and consequently the shafts are uniformly short, seldom exceeding a length of 10 millimeters. This reduced length combined with a width of over 200 micra gives them a unique, truncated appearance. They differ from hairs of all other families of the order in lacking a medulla (Fig. 6), which in other aquatic forms is generally reduced but not absent.

Order RODENTIA

The hairs of six of the nine rodent families occurring in California are characterized by the presence of a compound medulla. This compound structure, which consists of separate medullary aggregations arranged in longitudinal parallel rows and varying from two to eight abreast, gives the medullary region a somewhat polka-dotted appearance (Figs. 9, 11). The only hairs with which the shafts of these six rodent families might be confused are those of the order Lagomorpha. However, hairs of the family Leporidae can be easily distinguished by their weak medullary compounding and a pattern of irregular, rectangular medullary cells (Fig. 12). Hairs of the family Ochotonidae can be differentiated from those of the rodent families except the Aplodontiidae by a maximum width which exceeds 75 micra and by having no more than four medullary aggregations abreast. The Aplodontiidae differ from the Ochotonidae in their greater length (25 millimeters, as compared to

17 for the Ochotonidae), greater width (81 micra), and a smaller number of medullary aggregations abreast (2).

The other rodent families occurring in California, the Castoridae, Zapodidae, and Erethizontidae, possess hairs which either lack a compound medulla or have one very weakly developed. The criteria for distinguishing them from hairs of other mammals will be discussed under their respective family headings.

SCIURIDAE

The compound medulla present in hair of the Sciuridae distinguishes them from those of the families Castoridae, Erethizontidae, and Zapodidae, which have feeble compounding if any. The shafts are usually crossed by two or more pronounced, dark bands (Fig. 7), and this banding serves as a major criterion for differentiation from the other families of the order with compound medullae. The few hairs without such bands can be identified by a length in excess of 28 millimeters and a width which reaches 170 micra. The exception to this is the genus *Glaucomys*, whose shafts lack banding but have a length of only 15 millimeters and a width of 47 micra. The gradual tapering of the shafts of *Glaucomys* serves to differentiate them from those of the genera *Microtus* and *Dipodomys*. Differentiation from the family Aplodontiidae is based on the brown tip of the hairs of *Glaucomys*, which contrasts with the uniform coloration of the hairs of the mountain beaver.

GEOMYIDAE

Hairs of the Geomyidae differ from those of the Castoridae, Erethizontidae, and the Zapodidae in having a prominent compound medulla, which is either poorly developed or absent in hairs of the other three families. They differ from those of the Sciuridae in lack of banding and in their relatively short length, which rarely exceeds 12 millimeters. This short length also distinguishes them from shafts of the Aplodontiidae and all members of the family Muridae except the genus *Mus*, from which differentiation must be made on the basis of the gopher hairs' lack of pigment granules in the proximal part of the cortex.

The hairs of this family are similar to those of the Heteromyidae but they can be distinguished by the fact that their granular, cortical pigmentation is restricted to the distal fifth of the shaft while in the Heteromyidae cortical pigment extends conspicuously along the distal three-quarters of the shaft and scattered granules are frequently present to the very base. An additional criterion for identification is the fact that hairs of the Geomyidae gradually taper proximally (the basal part of the shafts being reduced by half the distal diameter of 60 micra for some distance along their length) while hairs of the Heteromyidae are relatively uniform along their entire length, tapering abruptly, often within the distance of a millimeter, at the ends.

The hairs of the Cricetidae also bear a close resemblance to those of the Geomyidae but differ in a greater amount of proximal tapering. Their length, width, and medullary width all average greater than the same measurements for the gophers.

HETEROMYIDAE

The hairs of the Heteromyidae differ from those of the Castoridae, Zapodidae, and Erethizontidae in possessing a well developed compound medulla and from those of the Aplodontiidae in the smaller length of their shafts (17 millimeters). Most of them can be differentiated from hairs of the Muridae, except for the genus *Mus*, by widths which do not reach 75 millimeters, and the others can be differentiated on the basis of the number of medullary aggregations abreast, the distribution of the cortical pigment, or the degree of tapering of the shaft. The hairs of *Mus* can be distinguished by the brown coloration of the distal third of their shafts and by their proportionate length and width. The Heteromyidae differ from all the Sciuridae except the genus *Glaucomys* in not having banded shafts. The abrupt tapering and extensive pigmentation of the shafts of the Heteromyidae serve to differentiate them from those of the Geomyidae and Cricetidae, although hairs of the genus *Dipodomys* are sometimes difficult to distinguish from those of the latter families. The genus *Dipodomys* differs from *Glaucomys* in having more abruptly tapered shafts, and the genus *Perognathus* differs in shorter shaft length (not exceeding 12 millimeters). *Perognathus*, however, presents a varied picture as regards hair shafts, some members having short, broad hairs and others having longer, relatively narrow ones.

CASTORIDAE

The hairs of the Castoridae may be distinguished from those of others in the order by a medulla which occupies nearly a third of the shaft width of 125 micra, which lacks compounding, and which is constricted about 10 millimeters from the tip. The homogeneous coloration of these shafts can be used as an additional criterion for differentiation. The hairs differ from those of the Zapodidae in their greater length (50 millimeters) and from the Erethizontidae in shorter length and lack of banding. As their medulla is not compounded these shafts could be confused with those of some carnivores, but they can be distinguished from hairs of the Ursidae by smaller length and from hairs of the genera *Enhydra* and *Lutra* by greater length.

CRICETIDAE

The well developed compound medulla of the hairs of the cricetine rodents serves to differentiate them from those of the Castoridae, Zapodidae, and Erethizontidae. Lack of prominent banding distinguishes hairs of all the Cricetidae except *Neotoma* from all the Sciuridae except *Glaucomys*, and the latter can be distinguished by its length and width and its more gradual tapering. With two exceptions hairs of the Cricetidae can be differentiated from those of the Aplodontiidae on the basis of smaller length (not over 25 millimeters). The two genera *Sigmodon* and *Neotoma*, which are not characterized by hairs of lesser length than those of the Aplodontiidae, can be differentiated by the presence of more than two medullary aggregations abreast. Except for the genera *Sigmodon* and *Ondatra* hairs of the Cricetidae can be distinguished from those of all the Muridae but the genus *Mus* by widths of less than 75 micra. *Sigmodon* and *Ondatra* can be distinguished by their

more restricted distal cortical pigment. The criteria for differentiating the genus *Mus* and the families Geomyidae and Heteromyidae from the Cricetidae have been discussed under their respective family headings.

The hairs of this family present great variations in general form and size. The greatest length and width is found in the genus *Ondatra*, in which the hairs attain a length of 35 millimeters and a width of 111 micra. The genus possessing the next largest hairs of the group is *Sigmodon*, in which the shafts reach a length of 16 millimeters and a width of 71 micra. The genus *Reithrodontomys* has the only guard hairs of the family which are marked by prominent strictures. With the exception of the genus *Neotoma* all of the Cricetidae possess some degree of development of a spatulate tip, though never such a pronounced one as that of the Insectivora. The most difficult genera to distinguish from one another, due to overlapping measurements of length, width, and medullary width, are the *Phenacomys*, *Clethrionomys*, and *Microtus*. The genera *Onychomys* and *Peromyscus* also differ very little from one another on the basis of general appearance or hair measurements.

MURIDAE

A compound medulla distinguishes the hairs of the Muridae from those of the rodent families Castoridae, Erethizontidae, and Zapodidae, in which the medulla is compounded weakly if at all. The shafts of the Muridae differ from those of all the Sciuridae except *Glaucomys* in not being banded, and the hairs of *Glaucomys* can be distinguished by their length (15 millimeters) and width (seldom exceeding 47 micra). They differ from those of the Aplodontiidae in having more than two rows of medullary aggregations abreast. Except for the genus *Mus* the Muridae differ from most of the Heteromyidae, Cricetidae, and Geomyidae in having a greater shaft width, which exceeds 75 micra. Differentiation from the remaining members of those three families can be made on the basis of the number of medullary aggregations abreast, or the distribution of cortical pigmentation, or, in the case of the genus *Perognathus*, the degree of tapering of the shaft.

The hairs of the genus *Mus* are smaller in both length and width than those of the genus *Rattus* and may easily be confused with the similarly small hairs of some other rodent genera. However, they can be differentiated from the hairs of any of the Heteromyidae with which they might be confused by the brown coloration of the distal third of their shafts. The presence of brown pigment granules extending into the proximal area of their cortex distinguishes them from shafts of the Geomyidae. The small length of the *Mus* hairs, which seldom exceeds 7 millimeters, serves to differentiate them from those of most of the Cricetidae, but other criteria must be employed for differentiation from hairs of the remaining cricetids, which also have a small length. The shafts of *Mus* differ from those of the genera *Onychomys* and *Peromyscus* in a greater width, which reaches 42 micra. They differ from those of *Clethrionomys* and *Microtus*, whose width reaches 70 micra, in smaller width, and from the hairs of *Reithrodontomys* in not possessing strictures.

APLODONTIIDAE

The shafts of the Aplodontiidae are 25 millimeters long and 81 micra in width. Their maximum number of medullary aggregations abreast is two, and these appear in the basal part of the hair. The length and width, the small number of compound aggregations abreast, and the absence of banding distinguish hairs of this family from those of all others of the order.

ZAPODIDAE

Hairs of the Zapodidae reach a width of 105 micra and a length of 13 millimeters, which is shorter than that of the Erethizontidae or Castoridae. Weak medullary compounding, almost absent in many cases, serves to differentiate these hairs from those of all other rodents. They can be distinguished from hairs of some *Perognathus* with which they might be confused on the basis of greater length and lesser width.

ERETHIZONTIDAE

The hairs of the Erethizontidae attain a length of 110 millimeters and a width of 405 micra. Their lack of prominent compounding differentiates them from the shafts of other rodents, and their length and width makes them difficult to confuse with any of the non-compounded hairs of California mammals.

Order LAGOMORPHA

The hairs of the Lagomorpha more closely resemble shafts of the rodents than those of any other group of California mammals. Criteria for differentiation will be mentioned in the family diagnoses.

OCHOTONIDAE

The hairs of the pikas are most easily confused with those of members of the order Rodentia. However, a maximum width of over 75 micra distinguishes them from hairs of the Geomyidae and from most of the Heteromyidae and Cricetidae. They differ from hairs of the heteromyid genus *Perognathus*, whose width is sometimes in excess of 75 micra, in a lesser number of medullary aggregations abreast, usually not more than three. Their length of 17 millimeters serves as an additional basis for differentiation from shafts of the cricetid genera *Sigmodon* and *Ondatra*, and their lack of banding distinguishes them from the hairs of all the sciurids except *Glaucomys*, from which they differ in having a greater length. They differ from hairs of the Muridae in possessing a smaller number of pigment aggregations abreast and from those of the Aplodontiidae in shorter length. They can be differentiated from shafts of the Leporidae by their medullary compounding, which is weak in rabbit hairs, and by their absence of the cellular medullary pattern characteristic of hairs of the Leporidae.

LEPORIDAE

A division of the medullary region into rectangular, cell-like patterns, occasionally outlined by pigment granules (Fig. 12), readily differentiates hairs of the Leporidae from those of any other family within the boundaries of California. However, hairs of the species and races within the family are

often difficult to distinguish from one another without adequate sampling, due to the similar appearance of their shafts.

Order Artiodactyla

The width of the shafts of Artiodactyla, which range in different genera from maxima of 107 micra to 450 micra, usually serves to differentiate these hairs from those of other California mammals. Hairs of the Erethizontidae and the Canidae may approximate this width, but are banded. Those of the Ursidae also approximate this width, but the Artiodactyla hairs can be distinguished by their greater medullary width, which comprises at least two-thirds of the total shaft width. All the genera of Artiodactyla except *Bison* are characterized by a peculiar, honeycombed medullary pattern (Fig. 13).

Cervidae

The hairs of the Cervidae possess a narrower width, ranging from 175 micra to 305 micra, than those of the Antilocapridae, which reach 450 micra. Their dark distal region is sufficient to distinguish them from shafts of the Bovidae, and their width and honeycombed medullary pattern differentiate them from hairs of the genus *Bison*.

Antilocapridae

A width which reaches 450 micra and a distinctive color pattern (an orange-yellow tip on an almost colorless base) serve to differentiate hairs of the Antilocapridae from those of all other members of the order as well as from all other California mammals.

Bovidae

The hairs of *Bison bison* have the narrowest width (107 micra) of any group within the order, and this characteristic distinguishes them from the hairs of other members, including *Cervus*, which they may resemble in color. Hairs of the genus *Ovis* can be distinguished from those of the Antilocapridae by their narrower width, reaching 265 micra. From those of the Cervidae, shafts of the genus *Ovis* are distinguished by their smaller, dark tips, which are restricted to about 2 millimeters of the shaft length.

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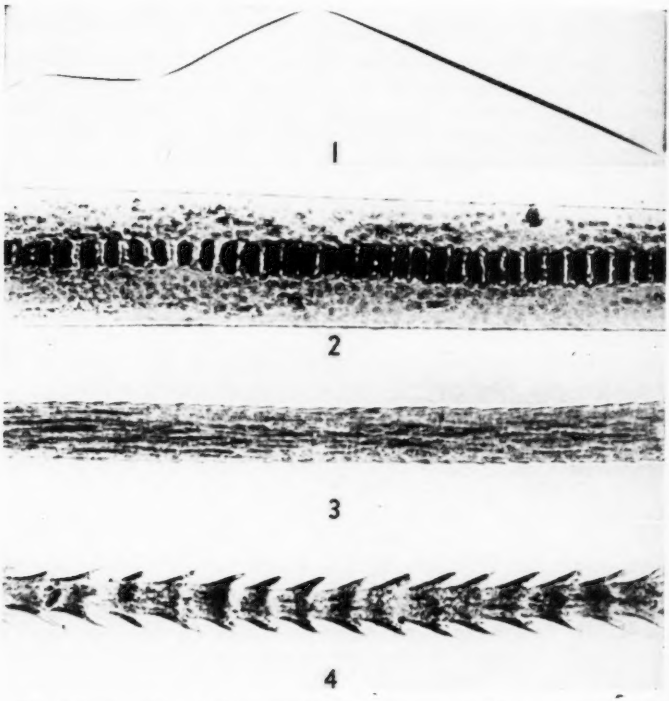

Figs. 1-4.—1. Hair of *Sorex trowbridgii montereyensis*, Monterey shrew (19×). Strictures and spatulate tip are diagnostic of insectivores. 2. Distal section of hair of *Scapanus latimanus dilatus*, Klamath mole (381×), showing narrow, discontinuous medulla. 3. Tip region of hair of *Myotis evotis chrysonotus*, golden long-eared bat (619×), indicating absence of medullary region and relatively inconspicuous scales. 4. Distal region of hair of *Tadarida mexicana*, Mexican free-tailed bat (444×), showing prominent lateral extensions of cuticular scales.

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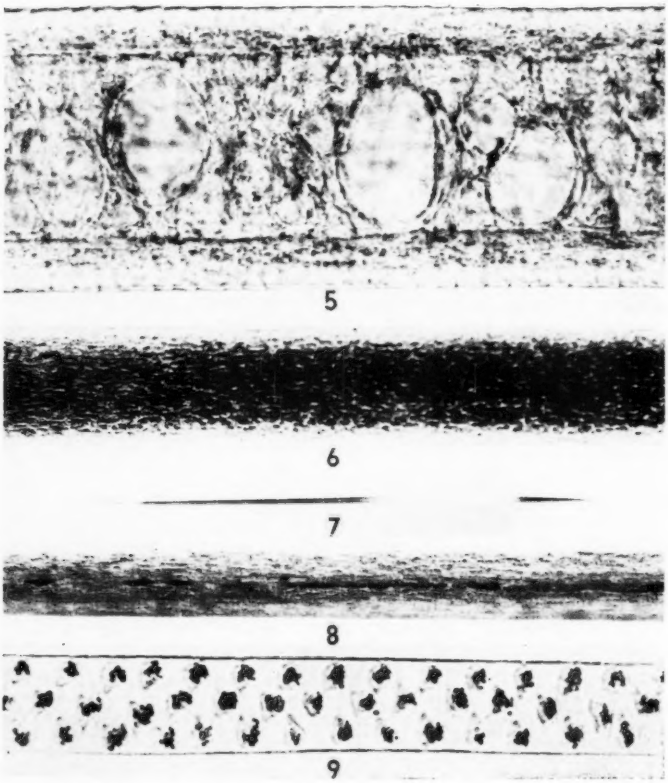
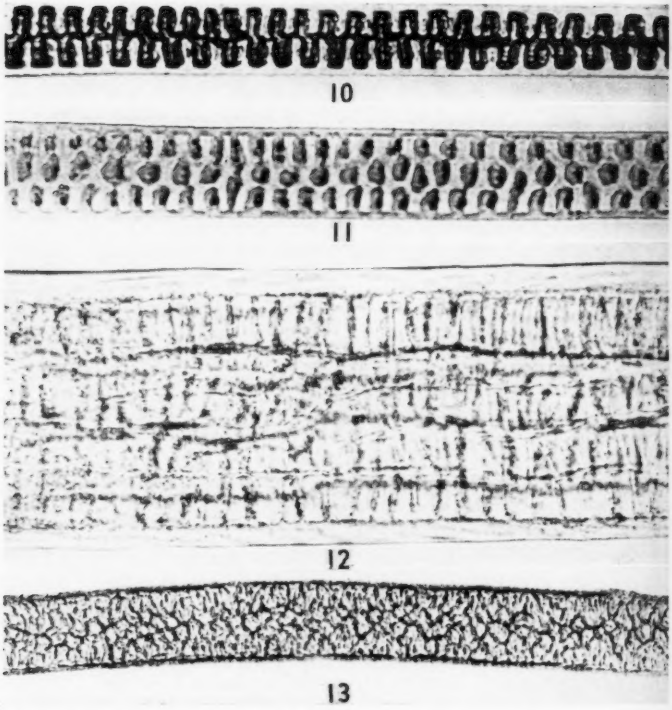


Figs. 5-9.—5. Section of hair of *Felis concolor browni,* Yuma mountain lion (365×). Note apparent vacuoles in medulla. 6. Section of hair of *Phoca richardii geronimensis,* California harbor seal (78×). Absence of medulla allows increased granular cortical pigment to be noted in the central shaft area. 7. Hair of *Citellus variegatus grammurus,* Rock squirrel (63×), a banded hair with a distal and basal light band. 8. Part of the shaft of *Castor canadensis shastensis,* Shasta beaver (107×), showing fragmental medulla on left, continuous on right. 9. Section of the hair of *Microdipodops megacephalus dickeyi,* Dickey kangaroo mouse (432×), indicating the medially concave-laterally convex chambers containing the pigment granules.



Figs. 10-13. Sections of hairs.—10. *Onychomys torridus clarus*, Owens Lake grasshopper mouse (314×). Peculiar black, ladder-like appearance of medulla is due to presence of air. 11. *Onychomys torridus ramona*, Ramona grasshopper mouse (342×). Pigment granules are concentrated in cortical invaginations in the medulla. Absence of air contrasts with appearance in Fig. 10. 12. *Lepus californicus deserticola*, desert jack rabbit (401×). Rectangular cell pattern of medulla is outlined in pigment granules. 13. *Odocoileus hemionus hemionus*, Rocky Mountain mule deer (98×). Honeycombed medullary pattern is diagnostic of the Artiodactyla.